Concrete

Vol. 21 Detroit, October, 1922 No. 4

The Offense of Cost Ignorance

IT is an offense against all one's fellow-workmen to do a contracting job without making a profit on it.

Yet the contracting field is full of Happy Hazards, who, not knowing what it costs them to do work, are selling their services and their materials too cheap, and going gradually and blindly into bankruptcy.

This not only ruins eventually the contractor who does not know his costs, but it indirectly robs the contractor who does know, and who, knowing what his work costs him, in time, materials, and overhead, must continue to be a high bidder and lose out on many contracts. There are exceptions, of course, in particularly favorable instances where a contractor has so thoroughly established a reputation for dependable work that he can make contracts on a non-competitive basis.

All hail the contractor who systematizes, organizes and refines his operations so as to do work the most economically. But the contractor who does it, not economically, but cheaply, ought to be forced out of business.

It is a slow process to bring order out of chaos in the contracting field in this respect, but it is gratifying that the effort is being made. The Associated General Contractors of America, Inc., has spent some time on the matter of estimating and cost accounting, not in an effort to bring about uniformity of estimates and bids but a uniformity of methods in arriving at the result. An estimating guide sheet has been drawn up in tentative form, enumerating the items of cost to be accounted for in the construction of a building. A meeting of the A. G. C. estimators was held in New York Sept. 11, for the purpose of criticizing and offering suggestions to the tentative estimate form, and it is hoped that the sheet will be in final shape in the near future. Second, it is proposed that a cost accounting system will be made to parallel roughly the estimating sheet, thus enabling the establishment of a bogie score, or means of comparison between the two. It is hoped to have all of this work complete by the end of the present year.

* * *

Cement, Coal and the Public

THAT portland cement production during the month of August exceeded that of any preceding month on record is evidenced by figures just issued by the United States Geological Survey, based mainly on actual reports from producers. Shipments for the month exceeded shipments for the first quarter of this year. These reports are significant, in view of the fact that a number of the mills were operated below capacity output or were entirely closed because of the coal shortage.

Added to the increased cost of coal in cement production, and an almost general increase in labor costs and sack charges, what has been referred to as the "Annual Jinx"—car shortage—has to be contended with. This car shortage affects not only the price of cement, but that of aggregates.

Under present manufacturing methods about 200 lbs. of coal are required to each barrel of finished cement, so an increase of $1.00 per ton in the price of coal makes a corresponding increase of 10c per barrel in the price of cement. This indicates how closely costs in cement manufacture and likewise concrete construction are linked with the coal industry.

In a recent address on "The Public and the Coal Industry," Herbert Hoover, Secretary of Commerce, stated that in the end the issues of the struggle between employer and employee in the industry are consciously or unconsciously imposed by pinching the welfare of 99% of the community who are not parties to the quarrel. The public eventually pays the bill through subsequent prices, and therefore has a right to a voice in the whole business.

What is most needed in the interest of the public is a definite settlement that will end the periodic war in the coal industry, rather than another temporary agreement which only defers final settlement.

* * *

How the Bureau of Standards Is Aiding the Builder

IF it can be shown that the majority of building laws require too much or too little in the way of wall thickness, amount and quality of reinforcement, etc., to withstand safely the loads to which a structure is subjected, an economic waste is being permitted with loss of money to the public.

From a thorough study of the building codes of practically every city and town in the United States, the Bureau of Standards believes that this condition does exist, and it is, therefore, attempting (first) to establish reasonable requirements to govern building construction, and (second) to get the different municipalities and the branches of the Federal government to incorporate these requirements in their codes.

Any one who knows about construction work can appreciate that this is a big job, and it cannot be accomplished even in months, but will probably take a number of years for completion. However, a start has been made and results of real value have already been brought about.

For instance, a certain design of floor slab was based

on stresses in the material much higher than those permitted as safe by the older specifications. Such floor slabs, however, have been built and have safely withstood the usual loads. The Bureau considered that possibly after all the design was safe and that the factor of safety in the old requirements was higher than is necessary and through co-operation with the industry secured the building of a floor slab at Waynesburg, Ohio, containing full-size panels of different spans. It loaded these to several times the designed load and measured the stresses at intervals to study the behavior of the various members. That slab is still standing after two years. Some cracks have opened up, and the deflections at certain points are pretty large, but that was to be expected. The point is, that a *practical* test over a long period shows the construction to be safe for more load than the usual requirements would permit, a decision which will mean everything to those interested in improved building construction.

Can rerolled steel be used with safety as reinforcement for concrete? Some thought yes, some no. The Bureau may have had an opinion, too, but it didn't state it without facts to back it up. It carried out a careful investigation to compare the relative performance of rerolled and new bars, and when it was found out the conditions under which the rerolled steel was safe for this work, it let the public know the facts.

Similarly with concrete houses. Everyone knows there is a tremendous demand for inexpensive and durable houses in our cities. Concrete appears to have many advantages for buildings of this type, but before the Government felt like taking a stand one way or the other on the concrete house proposition, it wanted facts as to how concrete houses in actual service were liked by their owners, how they were standing up under the weather, whether an artistic external appearance could be obtained, etc. The branches of the Government interested in the subject asked the Bureau for data, and accordingly an expert has made a tour, including practically every community where concrete houses have been built on a large scale. The result is a long report, now in course of preparation, to the Division of Building and Housing, and the Building Code Committee of the Department of Commerce, stating that the concrete house has proven satisfactory under many conditions, and is well worth consideration.

The city of Los Angeles has had a lot of trouble with failures of clay and cement sewer pipes, and at last the industries sent their cry for help clear across the continent and asked the Bureau to give them a hand. Los Angeles is a long way off, but not as far as the town hall of Johannesburg, South Africa, which had an auditorium where no speaker could be heard because of acoustical defects, a condition which the Bureau was able to suggest remedies by correspondence, and so its experts took hold of the sewer pipe problem. It is working with the cooperation of the clay and cement pipe manufacturers and the city engineer. The program of the investigation will mean digging up and inspecting sections of pipe from laterals in many sections of the city, and the replacement of these with tested pipe for further examination. However, that's only a minor part of the work. The main part will be to install small sections of pipe in manholes in such a way that a part of the specimens will be submerged in the sewage and a part exposed only to the action of the sewer gases. Of course, the exposure points have been selected so as to be typical of conditions throughout the system, and at these points analyses of the sewage and gases will be made at regular intervals to determine the concentration of ingredients which may be injurious to the pipes. Besides helping the city to select a satisfactory material for their sewer pipes, the Bureau has a much more important and broader proposition in view. It is going to find out, if possible, whether there is any relation between the rate or extent of deterioration of pipes and the concentration of damaging elements in what goes through them—in this case sewage and sewer gases. If there is, an engineer need only know the character of the material which the pipe will be called upon to carry, in order to specify the right kind of pipe.

Somewhat similar to the above mentioned work is that which the Bureau has been carrying on for years on the durability of concrete in alkali and sea water. Specimens consisting of experimental drains and large concrete blocks were exposed to severe alkali conditions in certain sections of the arid belt from New Mexico to Montana in 1913 and 1915, and the Bureau has inspected them from time to time to see how they were standing the attacks of this water. The results have now been given to the public in one of the regular publications of the Bureau, known as Technologic Paper No. 214.

Instances where the Bureau is actually saving "hard cash" to the builder and the public might be multiplied indefinitely, but these instances noted are typical.

Transporting Construction Materials

The railroads now may supply open-top coal cars for the transportation of road and building construction materials after such cars have discharged their coal lading and the destination of such commodities is in the direction of but not beyond the mines to which the cars are being returned. The above became effective at midnight, September 20, by order of the Interstate Commerce Commission. Such use of the returning coal cars is permissible, however, only when it does not materially delay or minimize the production and transportation of coal. Carriers were armed with authority by the Commission to place an embargo against any shipper who fails or refuses to load and unload such cars within 24 hours after placement.

Permission to use the open-tops on their return to mines for the movement of the commodities named was given, the Commission stated, because there are extensive road-building projects with uncompleted gaps, which, in the public interest, should be completed before cold weather sets in, and for which appropriations have been made by the state and federal governments. The Commission, also, remarked that there are large building programs under way which must be completed without undue delay to avoid serious loss. Ore, mine supplies for current operation, and fluxing stone for furnaces also may be moved in the coal cars.

Coal priorities to public utilities and other preferred classes of consumers have been removed by the Commission. By virtue of the general priority which is given both to the movement and use of open-top cars for coal, the effect of the change now made is to advance all coal into the priority class and industrial consumers have their chance with the rest, instead of only those classes of consumers formerly embraced in the priority designations.

The Commission observed that the production of bituminous coal has increased to approximately 9,500,000 tons per week, and should, with reasonable use, take care of current needs, if panic, undue storage, and waste of fuel and equipment carefully are avoided.

Concrete Warehouse, Oakland, Calif.

FIG. 1—REINFORCED CONCRETE STORAGE WAREHOUSE OF H. S. DAWSON, STOCKTON, CAL.; GLENN ALLEN, ARCHITECT

The pictures show the reinforced concrete storage warehouse of H. S. Dawson, on Oak street, Stockton, Cal. It is the work of Glenn Allen, architect and construction manager, Stockton. The surface enrichment is in polychrome on cast concrete ornaments, with inserts of burned clay tile for other decorative details.

Mr. Dawson has adopted the Egyptian style for all of his warehouses. An earlier structure was described and illustrated in CONCRETE for July, 1921. Similar methods were used in the work here shown.

The work is especially interesting not only in its lines and masses, but in the methods employed for surface enrichment. The frieze at the top is 4 ft. high, all of precast concrete, as are other decorative panels and ornaments used on the work.

The concrete surface of the structure proper is finished with portland cement stucco, the last coat being dashed on, using 1 part of Atlas white cement to 2 parts of Monterey white sand.

In the article previously published, details are shown of the methods of securing the precast concrete ornaments to the structural concrete. Color in the frieze and other ornaments is obtained with enamels, especially prepared, being ground and mixed in one-half turpentine and one-half spar varnish for a binder; for a second coat, the same material, using 1 part of turpentine to 1 gal. of varnish. On this 2-coat base the final color work was done, the colors being mixed in spar varnish. Mr. Allen announces that the colors have been highly satisfactory as to durability, and have the appearance of matt glazed terra cotta.

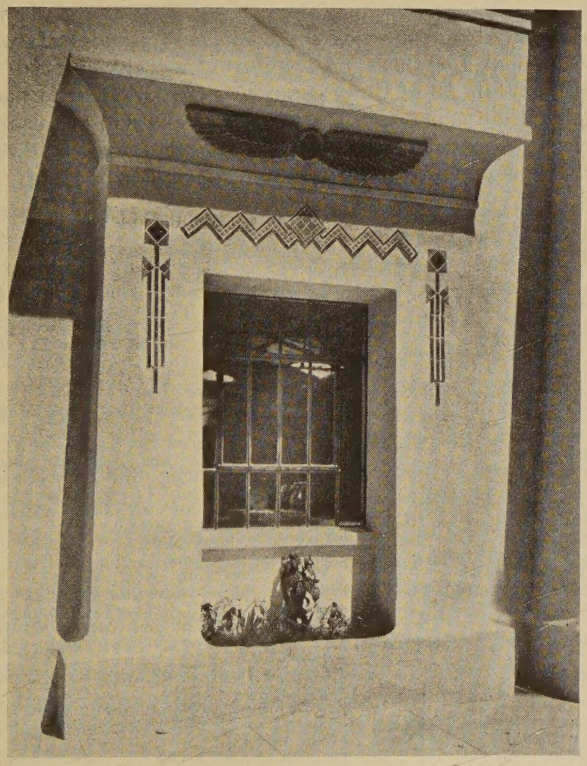

FIG. 2—DETAIL OF WINDOW, SHOWING PRECAST CONCRETE ORNAMENT AND TILE INLAY

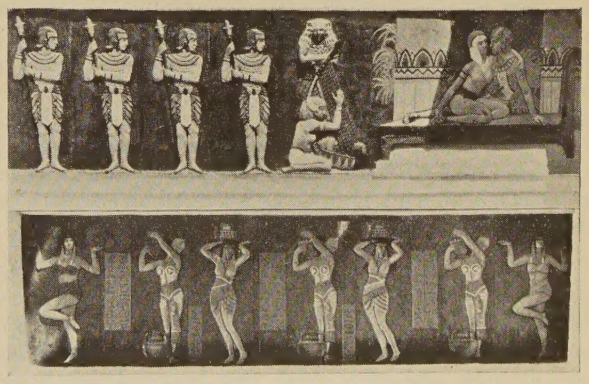

FIG. 3—DETAILS OF FRIEZE OF PRECAST CONCRETE PANELS, WITH ENAMEL COLORS PAINTED ON

The Most Competitive Business in America

By A. J. R. Curtis
Chicago

Selling concrete is without question one of the most highly competitive businesses in America.

Modern portland cement is almost the baby among construction materials. Portland cement-concrete is even more recent for the early portland cement was used almost exclusively for stucco work and mortar. Although it is true that the ancients successfully used concrete or similar constituency, they made it with a variety of natural cements; the concrete they used was without many of the valuable characteristics of the portland cement-concrete of today and was not reinforced.

The introduction of portland cement-concrete required creating an entirely new building industry, including men skilled in the design and use of the new material for its many purposes. The clay brick industry, for example, has had the training of many generations of bricklayers to fall back upon; the lumber industry finds its outlet through men trained through a hundred generations of carpenters but the concrete industry has had to train its own artisans without the experience of even a single generation to draw on.

The popular use of concrete, gaining rapidly as it has, indicates successful progress in business combat as keen, we venture to say, as exists in the commercial arena of any nation today. The United States Geological Survey reported the cement shipments for May (last figures available at time of writing) to be over 12,900,000 bbls., the greatest volume ever achieved. The 1920 and 1921 totals were about the same with nearly 100,000,000 bbls. shipped as against 76,000,000 bbls. for 1910. Compare these figures with the showing in the lumber industry—40,000,000 board ft. in 1910 and 33,000,000 in 1920, or that in the common brick industry for which unofficial figures have shown the output as having dwindled from some 9,000,000,000 to some 6,000,000,000 brick during this period.

The volume of concrete business has increased steadily with the exception of the war period, in spite of well intrenched and determined competition. Effective promotion efforts of the cement manufacturers, the trade press, gravel and stone producers and concrete products manufacturers have been very largely responsible. It may also be said in fairness that plenty of cement has nearly always been available except where coal or labor shortages have interfered with manufacture or transportation facilities have been inadequate. While coal and labor remained nearly stationary during the years before the war, the lower cost of larger quantity cement production, as well as the natural effects of competition in a well stocked market, had a noticeable effect in steadily lowering retail prices. These are some reasons why concrete has been and is making such handsome progress while competing materials slump.

In New York and some other large cities, natural stone and terra cotta recently have been finding in concrete dimension stone a competitor before which they go down to defeat; in New York, Milwaukee, Des Moines, Portland, Oregon, and other cities, time honored clay brick—after 4,000 years or more with a field to itself—has found concrete brick a worthy contender; the cream of

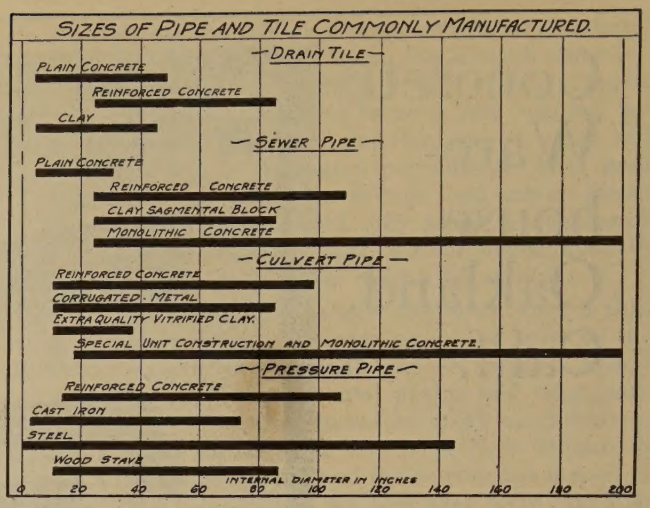

Chart Illustrating Leading Materials Competing with Concrete Pipe and Sewer Material of Different Classes and Sizes. Many Different Products Compete with Concrete for These Purposes.

the great drainage areas of the Mississippi and Missouri Valleys, and the irrigated empires of the west support a vast industry of thriving concrete pipe and tile plants. In many sections they already do more than half the drainage business and in some sections accessible to clay competition concrete is getting 80% of the business. In every big city the concrete frame building has taken its place beside the steel skyscraper and has all but supplanted steel for less lofty commercial structures.

The cement business has been so highly competitive that although there are some 85 companies now operating, 203 have been forced to abandon the business during the last few years, not counting the list of those which have been absorbed by others and still continue to operate as part of the latter.

The accompanying list of 30 typical uses of concrete indicate 76 important competing materials or an average of about 2½ competitors for each of these uses. It will be observed that most of these competing materials were established for these uses before concrete entered the field. While 28 of these competing materials are usually higher than concrete in first cost, 40 of them are usually priced below concrete and the remaining 8 are vacillating or irregular as to comparative first cost.

Competition of Portland Cement-Concrete

Use	Leading Competing Materials
Bridges	Steel, wood, stone
Building block	Common brick, hollow tile, natural stone
Conduits	Conduit tile, tar paper or tar fabric
Culverts	Corrugated metal, clay pipe
Dimension stone	Marble, granite, limestone, terra cotta, face brick
Drain tile	Clay tile
Fireproofing	Clay building tile
Floors	Wood, steel, floor tile, cork brick, Magnesite brick
Foundations	Natural stone, brick
Highways	Bituminous materials, gravel, broken stone, slag, paving brick, wood blocks, granite blocks
Houses	Wood, brick, hollow tile, stone, steel
Mortar	Lime, bricklayer's cement
Piling	Wood piles, steel piles
Plaster (wainscoting)	Lime, gypsum, enamel tile
Posts and poles	Wood, cast rion, steel, bronze
Roofing tile and shingle	Clay tile, slate, asphaltic shingles, wood shingles, metal shingles, composition roofings, zinc shingles, copper shingles
Large sewers	Clay brick, clay segmental block, natural cement
Small sewers	Clay pipe, cast iron pipe
Ships and barges	Steel, wood
Sidewalks	Paving brick, wood, cinders, gravel
Silos and grain tanks	Wood, circular tile, brick, galvanized steel
Structural building frames	Steel, wood
Stucco	Magnesite—all kinds
Subaqeous construction	Natural stone, natural cement, cast iron, bronze
Tanks	Wood, steel, cast iron
Water pipe	Cast iron, wood stave
Weights	Lead, stone, iron

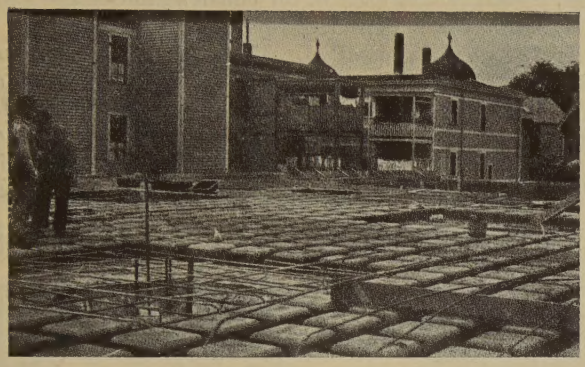

FIG. 1—(UPPER) PLACING STEEL DOMES ON SUPPORTING RIBS—(LOWER) PLACING REINFORCING RODS—DOMES IN PLACE

Grid Flat Slab Construction

The "Grid" flat slab construction of floors and roofs consists of columns with column capitals, a solid slab projecting beyond the capital with cantilever effect, and a slab with recesses in the under side throughout the remainder of the bays extending to the margins of the solid portions, the ribs between the recesses being reinforced with bars near the bottom, and the solid portion over the columns being reinforced near the top. The recesses are obtained by the use of removable forms. These forms are of 16 gauge sheet steel pressed out of one piece and are designed so as to permit of simple installation and of easy removal after the concrete has been cast in place.

This construction gives a ceiling with much the same appearance as the ordinary domestic waffle or grid-iron, hence the use of the name "Grid" flat slab. This type of reinforced concrete floor experiences flat slab action and is designed by the use of the same moment coefficients and other requirements as an ordinary flat slab.

Under present conditions it is believed that anything that will cut down the necessary amount of material and the number of hours of labor required to produce a certain piece of construction will be welcomed and investigated with keen interest by parties having to do with building operations. The most economical type of construction to attain would be the one in which every part of the structure was working up to its capacity or its allowable stress under the loading for which it was designed. The Grid flat slab approaches this type of construction as it gives a floor of the equivalent strength of the usual flat slab but with a large saving of concrete and steel reinforcement. Besides this saving in the floor slab itself there is a substantial saving in the columns and foundations of the building.

The removable steel domes which have been manufactured up to the present time are 8 in. deep by 19 in. square at the bottom and have a 2½ in. flange around the four sides. This gives a 5 in. rib by butting the flanges and a spacing of 24 in. c. to c. of ribs in both directions. These domes are very rigid so that the runways for wheeling the concrete may be laid directly upon them. They are oiled before the concrete is poured and since the sides have a bevel are very easily removed after the concrete has set. Each of the 8 in. domes replaces 1.5 cu. ft. of concrete.

The wooden centering is similar to that required for the solid flat slab except the shores may be spaced farther apart and the solid board deck is eliminated. The amount of lumber required to support the domes is about two board feet per square foot of area.

The advantages claimed for this type of construction are:

1. Saving in the amount of concrete, which is from 20% to 30%.
2. Saving in steel, from 10% to 20%.
3. Increased stiffness in floors, owing to the greater depth.
4. Saving in permanent dead weight of construction, which gives lighter columns and footings (a big item in pile foundation districts).
5. Increased spans, owing to reduced slab weights.
6. Better engineering design, as both steel and concrete are supplied only where needed.
7. Lighter shores and saving in wooden centering.
8. Cutting down the percentage of labor per square foot of floor space.
9. More attractive ceilings, doing away with the dull effect and board marks of the flat ceiling.
10. Better sound deadening properties.
11. More evenly diffused lighting.

There have been 16 buildings constructed in Boston and vicinity in which the Grid flat slab construction was used. The largest of these is the Noyes-Buick building, with a total floor area of about 200,000 sq. ft.

Edwin F. Allbright is the inventor of this type of construction.

CONCRETE is indebted for the above information to the Grid Flat Slab Corporation, 568 Columbia road, Boston, 25, Mass.

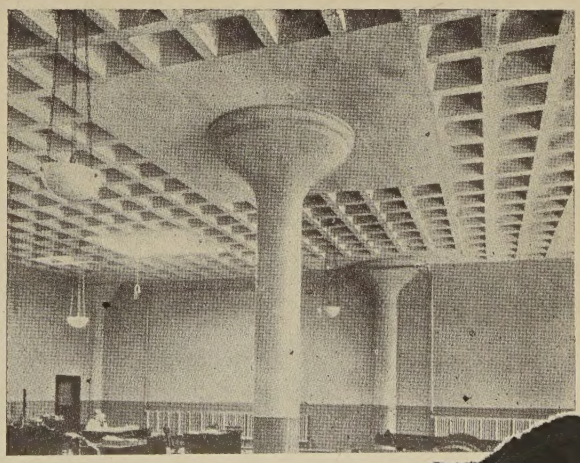

FIG. 2—CEILING WHERE GRID FLAT S
USED

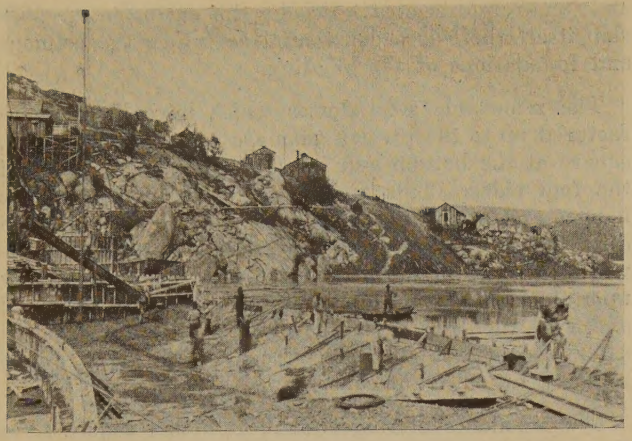

FIG. 1—CONSTRUCTION PROGRESSING WITH THE WATER IN THE RESERVOIR 10 FT. HIGHER THAN THE TOP OF THE DOWN-STREAM FACE OF MASONRY

Build Dam Against Rising Water

After a race with the rising water in the reservoir formed by the Barrett Dam, lasting several months, the dam was finally finished and at its completion had already impounded water which represented greater value to the city of San Diego than the cost of the dam amounted to. The dam is of gravity type, arched concrete masonry. The height of the dam above lowest excavation is 213 ft., the top length being 750 ft., and the thickness at the base 160 ft. Construction work was continually strenuous from the beginning to the completion of the work, but the results have proved very gratifying.

Construction with the funds provided by a municipal bond issue started February 1, 1920. Beginning with December 25, 1921, a considerable flood occurred and rain fell from that time on at the rate of about two inches a week for several months. Although the structure had been advanced to a height which would take care of the average run off from the drainage basin, the flood of December filled the reservoir to a height of 10 ft. above the top of the lowest section of masonry which had been placed in the dam.

The impounding waters were held back by a cofferdam connecting across to one abutment, and from that time on until the work was completed there was no time that the water in the reservoir was not higher than some of the lowest portions of the uncompleted but advancing masonry in the dam. The water was held out by means of stop planks across emergency spillway channels and by the forms for the upstream face of the concrete.

The work was advanced, in spite of the elements, sufficiently rapidly to prevent the dam being overtopped by the water at any time. As the water rose it was held back by the upstream base of the concrete forms, and by concrete masonry placed immediately adjacent to the upstream forms. Owing to the rapid advance of the water, only a small portion of the upstream forms could be removed.

By June 1, of this year, the masonry was 100% poured and the reservoir was 103% filled, that is, stop planks had been placed between the piers in the over-flow spillway section and the water was being temporarily held nearly 2 ft. above the fixed lip of the spillway. Two positive acting flash gates of steel are to be placed between the spillway piers ultimately. The water to a height of 8 ft. above the fixed lip of the spillway.

Work was carried on continuously day and night with an average force of 200 men. The record amount of concrete masonry placed in a single 8 hour shift was on October 26, 1921, and was 467 cu. yds. The dam and outlet tower contain in all 140,417 cu. yds. of concrete masonry. The first of this masonry was placed July 15, 1920. Rock and earth excavation required for foundations and abutments of dam amounted to 75,172 cu. yds.

Owing to the location, the following camp construction was deemed necessary in connection with the dam: 6 laborers' dormitories, 25 cottages for married employees, engineers' office, garage, school house, recreation building, warehouse toilet, wash house and bath, mess house, and office buildings, domestic water supply, sanitary sewer system and septic tank.

The entire plant used in the construction of the Lower Otay dam was acquired, dismantled and moved to the Barrett dam, and installed. Three cement stock houses were built with a capacity of 9,000 bbls., blacksmith and machine shop constructed and a 1,000 ft. quarry face opened up. Two concrete hoisting and distributing towers were used, one 160 ft. and the other 192 ft. high. The rock crushing plant, aggregate bins and mixers completed the construction plant.

Mass aggregate to the amount of 27.8% was used in

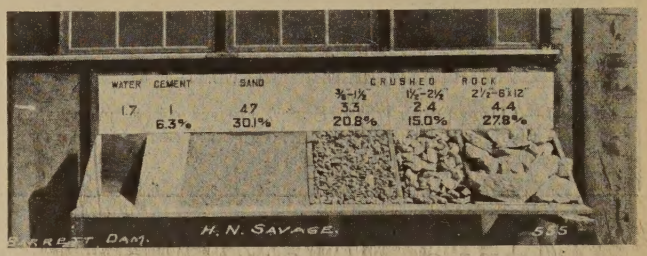

FIG. 2—DISPLAY SHOWING THE PROPORTIONS USED IN THE CONCRETE CONSTRUCTION AND THE PERCENTAGES OF THE VARIOUS MATERIALS, INCLUDING SAND AND THE COARSE AGGREGATE

making the concrete masonry. This is probably the first use of crusher run rock up to any such size of coarse aggregate in construction work of this kind. Many of the pieces were 13 in., and some 14 in. in over-all length. The proportions used in mixing the concrete are indicated in Fig. 2.

Great difficulty was experienced in delivering material to the site of the construction work, particularly the cement. The stock houses were filled in advance of the rainy season, but the shortest roads became impassable, necessitating the cement being hauled a distance of 25 miles. At one time the entire fleet of eight automobile cement hauling trucks was bogged.

The work was carried on under the direction and supervision of H. N. Savage, hydraulic engineer for the city of San Diego, Cal.

Employment of Engineers Continues Strong

Reports from more than 200 separate localities to the employment department of the American Association of Engineers on September 1 showed little trace of unemployment among professional engineers. Most reports mentioned scarcity of men for engineering work, particularly for the building field.

While fear was expressed from certain quarters of less construction and manufacturing activities due to car shortage, transportation difficulties and coal scarcity, the employment situation in general continued good. This condition can be expected to continue for several months, or at least until cold weather sets in, at which time construction work usually closes down.

Powder House Has Unique Design

The powder house constructed for the Chief Consolidated Mining Co., at Eureka, Utah, as shown in the accompanying illustration, is of rather unique design, it having been built in such a manner that in case of an explosion it would disintegrate.

In working out the design, it was decided not to use any large aggregate in the concrete, in order to decrease the damage to the least possible in case of an explosion.

The house was built in the shape of a catenary to allow for the least possible use of reinforcing, and covered with composition roofing. The construction is of concrete throughout, including the door.

In event of accidental explosion, the concrete is supposed to disintegrate into pieces not larger than 1/4 of an inch. Only sand and cement were used in mixing the concrete, proportions used being one part cement to six parts of sand.

The general dimensions of the structure and also interesting details are shown in the accompanying illustrations.

Construction work was done by Villadsen Brothers, Inc., Salt Lake City.

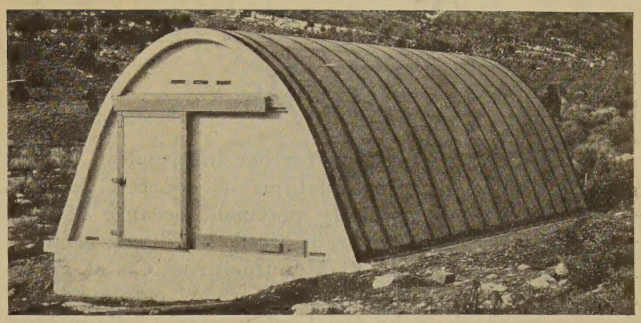

FIG. 1—COMPLETED CONCRETE POWDER HOUSE

An investigation to determine the feasibility of measuring sand for concrete in an inundated condition has been commenced by the Bureau of Standards. With small additions of moisture to sand, the sand swells—that is, the volume occupied by a given quantity of sand increases—and this increase sometimes reaches an amount as large as 38% of the original volume. Conversely, the quantity of sand in a measure of given size varies greatly with the amount of moisture in the sand. This fact makes it difficult to insure the same proportion between sand and cement in successive batches of concrete, because the precentage of moisture in sand varies greatly from time to time.

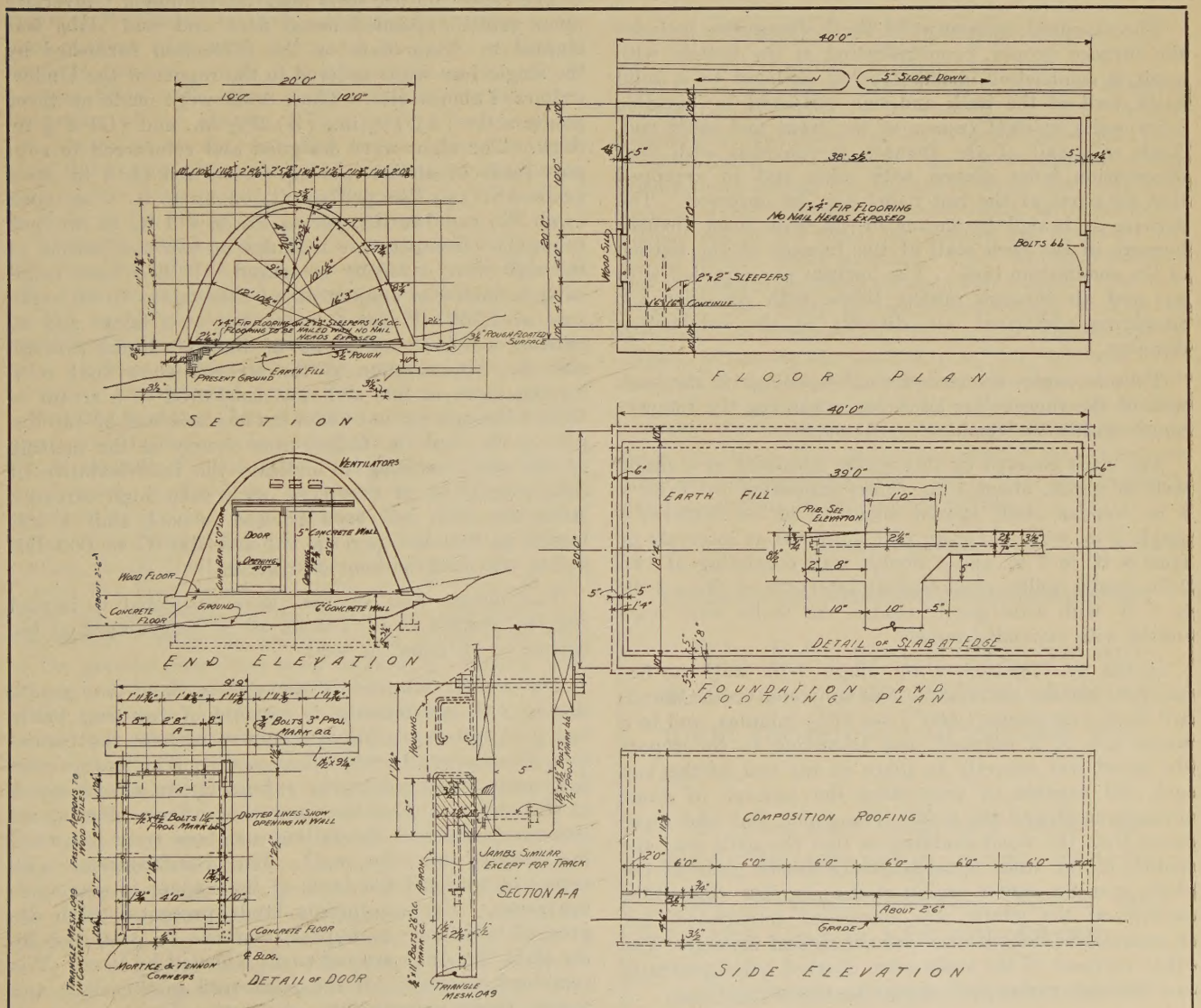

FIG. 2—POWDER HOUSE DESIGN DETAILS

Fire Test of Gunite Walls

In view of the need for further information on the subject of fire resisting qualities of concrete, a need which is believed especially pertinent because of fires which are occurring in reinforced buildings, such as at the plant of the Barrett Manufacturing Co. at Philadelphia, a brief resume of the methods employed and the results obtained by the Underwriters' Laboratories on tests made on walls built of gunite, as described in a report recently issued, are of special interest. The tests were made for the Cement-Gun Co.

In this work the regulations of the Underwriters, as well as recommendations of the American Concrete Institute provide that two samples must be tested, the first to be given what is known as the fire endurance test and the other the fire and hose stream test. The acceptance and rating of any wall is based on its ability to withstand:

First—The passage of flames.
Second—Resistance to decalcination or dehydration.
Third—Capability of restoration after fire.
Fourth—The period of resistance of the passage of heat.
Fifth—Resistance to destruction from impact or similar causes.

The standard equipment of the Laboratories includes the furnace proper, communicating at the bottom with a pit, a combustion chamber being enclosed by a solid brick wall at the back and one end, and by movable brick walls in steel frames at the front and other end. Each end wall of the furnace is provided with four observation holes glazed with mica and so arranged that all parts of the test panel may be observed. The furnace is heated by means of six 4-in. blast furnace burners in the back wall of the furnace at the bottom of the combustion tank. The burners are supplied with gas and air through mixing tubes, with provision for supplying additional air directly to the combustion chamber.

Thermocouples inserted through openings in the back wall of the furnace are used for measuring the temperatures within the combustion chamber.

The walls covered by this report consisted of a single wall of gunite about 1 in. thick, supported by 2 in. x 4 in. wooden studs spaced about 16 in. on centers; a single 2 in. wall of gunite with supports at intervals of from 4 ft. to 7 ft. and a double wall consisting of two 2-in. gunite walls, connected at intervals of from 5 ft. to 7 ft. with solid gunite studs. All walls were reinforced with expanded metal.

In the investigation of the single 1-in. wall the fire and hose stream test sample was subjected to the standard heats (maximum 1,500°) for 36½ minutes, and to a water test of 3 minutes, and according to the report the panel was securely in place at the end of the test and still capable of preventing the passage of flame through or around the wall. The gunite slab had separated from the wood studding so that the nails near the middle of the studs were generally drawn clear of the studs over the center region of the sample. The outer surface of the gunite was somewhat dehydrated, but in general the dehydration did not extend through. The other surfaces of the studs were charred quite generally and the felt carbonized except in places.

In the panel subjected to the fire endurance test, it was noted that the nails holding the mesh to the studs did not pull with the expanding slab, with the result that the spalling of the slab occurred to such an extent as to allow the passage of flames, so the fire was withdrawn at the end of 32 minutes.

The report further states that in the single test in which no spalling occurred the gunite and expanded metal drew away from the wood studding by pulling the nails which held the expanded metal. The fact that the nails are 3 in. long and spaced comparatively closely together, indicates the force developed by the expanding gunite and reinforcement. The conclusion is drawn that the tests indicate that the construction will not allow flame passage providing the gunite is given a chance to expand.

The other samples tested at the laboratory consisted of two slabs of the hollow double wall type, studs so spaced as to leave 18 in. on each side adjacent to the brick enclosure walls. The sample subjected to the fire and hose stream test was withdrawn from the flame at the end of one hour, while the fire endurance test sample remained exposed to the flames for a period of 4 hours and 15 minutes. At this time one of the thermometers on the unexposed face reached 340°, although the average temperature of the five points was 263° F. The heat of the exposed face at the time was about 2,030° F.

The report on fire tests made at Columbia University upon gunite expanded metal floor and roof slabs was studied to obtain data on the protection furnished by the single face walls covered in the report of the Underwriters' Laboratories. These tests were made on three gunite slabs (A) 1½ in., (B) 2¾ in., and (C) 2¼ in. thick. The slabs were designed and reinforced to support loads of 40 lbs. per sq. ft. on a 6 ft. 3 in. span (slab A); 150 lbs. per sq. ft. on an 8 ft. 6 in. span (slab B), and 150 lbs. per sq. ft. on a 6 ft. 10 in. span (slab C). Temperature readings on top and bottom of the slab were carefully measured. It had been originally intended to subject all of these slabs to an exposure of 1,700° F. for 4 hours, but at 2 hours and 56 minutes a hole about 24 in. in diameter broke through slab B. Examination of the stresses show that reinforcing mesh in this slab was subjected to a strain of 19,400 lbs. per sq. in., under the imposed load of 150 lbs. per sq. ft., and the failure was clearly in the melting of the steel, seeming to indicate the inadvisability of designing slabs of this type with such high stresses. After the slabs had been allowed to cool, slab A was loaded to 200 lbs. per sq. ft., and slab C to 600 lbs. per sq. ft., both without destruction.

Two double wall samples were subjected to impact test, by using a 15-in. I-beam 16 ft. long hinged at the bottom 13 ft. from the wall.

The results obtained in these tests show that gunite double wall construction is capable of resisting fairly heavy impact from falling members without the formation of openings through back slabs. The heavy reinforcement employed yields sufficiently to absorb much of the impact and at the same time offers sufficient resistance to prevent the falling members from penetrating deeply into the wall. The reinforcement also serves to transmit the force of the impact to surrounding areas. The reinforcing studs present a high degree of resistance to impact, and are so protected by the slabs that they are not easily affected by heat. The combined resistance of the reinforced gunite slabs and gunite studs increases the impact resistance of both of these parts.

Cold Glazing of Concrete in Germany

By F. A. Brackmann
Berlin

[Nothing which Concrete has published in many months has brought us so many interested letters of inquiry as a brief article by our German correspondent on glazing concrete. This further contribution seems to leave the subject with further developments to be awaited. It does not appear that this so-called glazing has yet reached a development entitling it to adoption for sanitary ware.—Editor.]

The cold glazing of concrete has naturally received much attention and quite a number of German firms have taken up manufacturing of glazed articles. The processes are, however, not offering an entirely satisfactory solution of the problem. Cold glazings of concrete have been produced since 1908.

It was found that portland cement and similar materials produced a gloss on a surface when they were sprayed on as a fine paste. This is attributed to colloidal elements which, on coming to the outer surface in setting, produce the glazing. Storing in a damp place or in water is assisting in the setting and increases the effect. The first patent was taken out by the German engineer Weithaler, in 1910. He simply sprayed a colored mixture of cement and water on to the moistened concrete product, which had afterwards to be left in a room filled with steam or put into water until the hardening of the glazing. This process, however, has not always given the expected result. Sometimes the gloss did not appear, or it lasted only a short time, or the glazing was destroyed by the efflorescence. The adding of chalk to the water has not improved the result.

Weithaler claims now to have discovered a glazing that will stand up against acids, but reports of reliable tests will have to be awaited before any judgment can be passed on the new process. Cement being the main ingredient of most of the glazing pastes used up to now, none of them could retain their appearance under the action of concentrated acids.

Another inventor, Mr. Friedrich, varied the original process of Weithaler. In mixing the paste he uses water which contains 1/5 to 1/10 of bituminous ingredients which have oxydized in the presence of alkalies and which do not contain any essential oils. The amount of water varies with the color used, and according to the surface to be treated. A bitumen preparation called Ceresit has been found especially useful. Ceresit prevents the destruction of the glazing by preventing efflorescence. After the cement, which is the chief part of the glazing paste, has been colored, it is mixed with the prepared water. The mixture is sprayed directly on to the surface, which is not to be wetted, as it has been found that otherwise the glazing loses its hold on the base and after a time may fall off. The spreading of the paste has not given any good results. Storing in a damp room or in water is not necessary, and the tiles are ready for use after 24 hours. This process has the advantage that it requires comparatively little time.

A process which also produces a good glazing has recently been introduced by another firm. Instead of putting a glazing on to cement tiles, the tile itself is made of a special mixture, the main part of which is probably a magnesite cement called sorelcement. The colored mixture is filled into a flat form with a bottom plate of glass or celluloid. This ensures a smooth surface and a bright glazing appears during the hardening. If it is intended to save color, only part of the mixture is colored, and a thin layer of it is spread on to the bottom plate. The mold is then filled up with the uncolored mixture. The tiles need not be put into a damp room or into water, and are ready to be used immediately after hardening. It is not claimed that these tiles can stand heat, weather or acids.

Up to now the cold glazing of concrete has been confined to tiles and other inside decorations, and quite a number of hotels, entrance halls, schools, etc., have lately been fitted with them. On account of their good appearance and their comparative cheapness, the demand for them is increasing and their manufacture has been taken up by a number of firms in different parts of the country. The covering of entire walls with a glazing by any of the described processes is not practiced, and the tiles are fitted to the walls in the ordinary way.

The following firms are producing cold glazed articles: A. Weithaler, Essen-Ruhr, Ruthstrasse 6 (Weithaler's patent); Gaigher & Penn, Munchen, Elisenstrasse 7; Kerament Werke G. m. b. H. Breslau-Carlowitz, Pachalystrasse (Friedrich patent); August Strittmater, Freiburg im Braisgau, Thurnseestrasse 51 (Strittmatter's patent, applied for).

Cement Buttons

By F. A. Brackmann
Berlin

Of the various uses to which cement has been adapted, cement buttons form an interesting example. A new process and machinery for manufacture have just been brought out by a German firm. A mechanical filling arrangement brings the cement-mixture into automatic presses, which press the form and stamp the small holes. Pushed out of the form, the buttons are prepared and left to harden under pressure. They are then tumbled and afterwards polished between two wheels. The buttons are then ready to be colored, which is done by spraying. It is remarkable that cement buttons can be colored in exactly the same way as ivory-nut and horn. In spite of the heavy increases in the price of cement, it is still a very cheap material for this purpose, and the fact that the buttons can be produced automatically in great quantities, and that consequently the wages per piece are comparatively low, augurs well for the extensive introduction of the cement button.

The Editors will welcome any authentic information bearing upon the subject of glazing concrete.

If you can add any information, based upon your experience or observations, pass it on to the readers of CONCRETE.

An Exact Theory of Flexure

of Homogeneous and Reinforced Concrete Beams[1]

By C. A. P. Turner, C. E.

The ordinary theory of flexure in general use today is based upon the assumption that:—

1. Any plane normal cross section of an unloaded beam before bending will still be normal and plane after bending.

2. That the material of the beam obeys Hookes law —Strain is proportional to stress.

Since the horizontal shear stress in a homogeneous beam of rectangular section increases as the ordinates of a parabola from the outer fibre to the neutral plane; these two assumptions in the exact sense are mutually inconsistent and contradictory.

Horizontal shear distortion, however, becomes of such small magnitude in a rectangular beam having a length more than fifteen times its depth that it may be disregarded and this inconsistency vanishes for practical purposes as stated by Rankine.

But while this is true for a long rectangular section, proper investigation of safety from buckling of the relatively thin web of a steel beam and shear failure in the rectangular concrete beam demands more exact consideration.

A square prism of vulcanized rubber the side of which has been marked off into equal squares before bending may be utilized to illustrate exaggerated but characteristic distortion under transverse stress.

Bending such a prism as shown in Fig. 1, two characteristic changes in the form of the elimentary squares are readily observable:—

1. The squares at mid span are changed into trapezoids by the change in length of their upper and lower faces. The diagonals of these trapezoids are stretched in the tension zone and shortened in the compression zone.

2. The squares at the end have been distorted into rhomboids, i. e., one diagonal has been lengthened and the other shortened.

Squares between the end and mid span have suffered both kinds of distortion simultaneously, viz:—

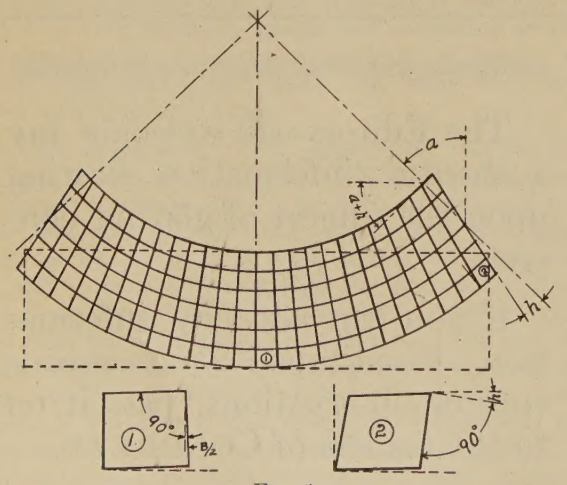

Fig. 1

[1]Advance publication of part of a copyrighted work by the author.

1. That due to the fibre elongation of bending.

2. That due to the horizontal shears which transfer the elastic reactions of the + or — elongation of the fibres to the neutral plane where the tensile and compressive stresses are brought into equilibrium.

Trapezoidal distortion is greatest at mid span and reduces to zero at the end where the fibre elongation from bending is zero.

Rhomboidal distortion, on the contrary, is zero at mid span and a maximum at the end.

Since these different distortions result from distinct though related causes and present different laws of summation analysis is simplified by treating each separately.

Thus that part of the deflection caused by fibre elongation may be separately determined and likewise that part caused by the shear opposing the elastic reaction of the fibre elongations. Then the sum of the parts equals the whole deflection.

Notation:

Let W = the load.
Let d = depth of the beam.
Let b = breadth of the beam.
Let e = the total elongation of outer fibre.
Let f = the maximum fibre stress at mid span.
Let a = the slope angle at x due to bending.
Let h = the slope angle at x due to horizontal shear.
Let M = Moment.
Let E = Youngs modulus.
Let F = Modulus of rigidity.
Let V = Vertical shear.
Let D = Deflection due to bending moment.
Let Δ = Total deflection, i. e., moment and horizontal shear.

CASE 1.—Simply supported beam centrally loaded of length L between supports and out to out length L'.

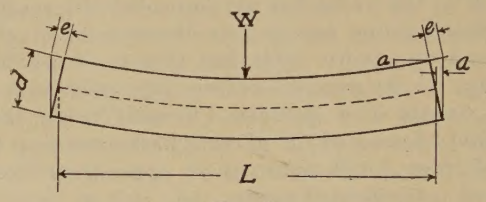

Fig. 2

In Fig. 2, e is the numerical sum of half the plus and minus fibre elongation and tan $a = e/d$.

Now, if the length L be considered measured by a large number of small units the total deflection is obviously the sum of the tangents of the slope angles for these units and the tangent of each slope angle as at the end is the numerical sum of the plus and minus extreme fibre elongation from mid span divided by d the depth.

Since the increment of elongation at x will be proportional to the moment at x the sum of the increments from mid span to x will be proportional to the sum of the moment areas from mid span and the mean value of tan a from the end to mid span would therefore be 2/3 tan a at the end. Hence the deflection—

$$D = \frac{e}{d} \times \frac{2}{3} \times \frac{L}{2} = \frac{eL}{3d} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Now $e = \frac{fL}{2E}$ because the moment between the support and load increase as a linear function of the distance x from the support.

Substituting this value of e in (1)

$$D=\frac{fL^2}{6Ed} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Formula (2) is much more convenient for computation than—

$D=\frac{WL^3}{48EI}$ of the ordinary theory to which it is readily reduced by substituting in (2) the value of—

$f=\frac{Mc}{I}=\frac{WLd}{8I}$ in which I equals the moment of inertia of the section.

Shear Distortion

Shear Distortion: Since rhomboidal distortion is zero at mid span the magnitude of the elongation increments must follow the lineal law of increase from the center of gravity of the section to the outer fibre. The total fibre stress couples at mid span will therefore be—

$+\frac{fbd}{4}$ and $-\frac{fbd}{4}$

Since the moment increase for a central load is a straight line function, the mean horizontal shearing stress equals

$q=\frac{fbd}{4bL/2}$ and the mean angular distortion $=\frac{1}{2}\frac{q}{F}=\frac{fbd}{2bL'F}$ in radians at the axis of the beam. Since this distortion is zero at the center and increases to a maximum at the end of the beam it will be twice as great as the mean or at the end the tangent of the slope angle—the distorted section makes with the normal will be—

$h=\frac{fbd}{bL'F}$

Since the horizontal shear increases as the ordinates of a parabola from the outer fibre to the axis, the value of h will vary from zero at the outer fibre to a maximum at the neutral plane and its mean value will be $\frac{5}{8}$ the maximum since the distorted section is a third degree curve derived from the summation of the parabolic shear stress areas.

As it is the mean value in $+$ and $-\frac{d}{2}$ that determines the deflection from horizontal shear distortion, Δs its value is

$$\Delta s=h\times\frac{5}{8}\times\frac{L}{2}\times\frac{2}{3}=\frac{5}{24}\frac{fdL}{L'F}$$

When L' the out to out length of the beam is four percent $+$ greater than L,

then $\Delta=\frac{fd}{5F}=\frac{6WL}{20Fbd}$

Which agrees with the deflection from shear for this case as given in Prof. Hudson's work on deflections and statically indeterminate stresses.

This case, however, is the only one that does agree since if the load be uniform the mean fibre reaction producing shear distortion is one-third greater than half the maximum and hence instead of getting $\Delta s=\frac{6}{40}\frac{WL^2}{Fbd}$ as Hudson does, wet get— $\frac{1}{5}\frac{WL^2}{Fbd}$ and for concentrated loads at the quarter and third points the divergence is even greater.

In tests (See *Engineering News*, Aug., 1909, p. 170) of Bethlehem and ordinary I-beams by Prof. Marburg the wide divergence between the experimentally determined modulus of elasticity E and that computed from deflection is accounted for by this error of common theory. See also discussion by Prof. Tilden and Marburg, *Engineering News*, Feb., 1910, p. 228.

In the I-beam because the resistance of fibre elongation is largely concentrated in the flange the distortion angle h is practically constant and the coefficient $\frac{5}{8}$ may be treated as unity and the total fibre resistance treated as $f\times A$ the flange area without noticeable error.

The same procedure is applicable to the concrete beam since the tensile flange stress is concentrated in the steel.

In the concrete beam where the value of Fc/Es is small such investigation is of even greater importance.

Before developing similar formulas for the concrete beam it may be well to note that from the method of deriving (5) the percentage of deflection caused by the reaction of fibre elongation is a constant for any given beam regardless of loading, but varies widely with the ratio of depth to span length.

That the so-called elastic curve of the ordinary theory exists only in the assumption upon which it is derived and is unrelated to the true neutral surface of the homogeneous beam and may be described as coincident therewith at only one point of the entire length that is at mid span.

Concrete Beams

In view of the mysterious complexity with which the simple mechanical action of the ordinary reinforced concrete beam has been befogged and obscured by our joint committeemen, it may be well to elucidate its predominent characteristic experimentally as was done with the homogeneous elastic prism.

Fig. 3

Cast a concrete beam 6 in. wide by 4 in. deep 7 ft. long, support it at the ends and it will carry six men without undue strain.

Then turn the beam with the steel in the top and it will break with but slight pressure at the center.

After breaking reverse and it will be found that the original load of six men will be carried just as well as before breaking because the abutting faces of the concrete take compression just as well after cracking as they did before and the steel takes tension just as it did in the first instance before breaking.

The steel takes direct tension because it cannot slip in the matrix. Cracking the concrete right across does not affect the strength to a noticeable amount as long as the steel does not slip in the broken segments.

Direct tension in the steel, compression in the concrete and shear resistance to sliding are the three elements of stability.

Shear in a homogeneous solid is equivalent to tension and compression at 45°, but in the flexure of the non-homogeneous prism of concrete and metal the directions of the principal tensions and compressions in the matrix differ from 45° to the steel because the lines of greatest horizontal shear in the matrix must equilibrate the lines of principal compression at the neutral plane, hence the lines of principal tensions make an angle greater than 45° to the steel and of compression less than 45°.

These induced lines of tension are called *indirect*

tension in contradistinction to *direct tension* in the steel element, or the lines of principal tension in the homogeneous beams. Lines of greatest horizontal shear in the tension zone of the concrete beam replace the lines of principal tension in the homogeneous beam and likewise lines of principal tension supplant in the tension zone of the reinforced beam lines of greatest vertical shear in the homogeneous beam. This redistribution stress is the inescapable consequence of the uniform distribution of horizontal shear between the steel and the neutral plane.

The discrepancy between applied moments and steel stress moment at mid span in the initial loading of a newly cured beam is attributable not to tensile resistance in the concrete of an elastic nature but to residual compression acquired in curing—see Chap. V, *Concrete Steel Construction*—Eddy and Turner, 2nd Edition for experimental evidence regarding its nature and amount.

In analyzing the concrete beam by the preceding method it will be simpler to deal with the steel elongation letting A equal the steel area and id its distance from the neutral plane.

Then,—

$$(6)\quad a=\frac{e}{2id}=\begin{cases}\frac{1}{3}\frac{fL}{Eid} & \text{for uniform loads.}\\ \frac{1}{4}\frac{fL}{Eid} & \text{for concentrated central load.}\\ \frac{3}{8}\frac{fL}{Eid} & \text{for loads at quarter point.}\end{cases}$$

$$(7)\quad \frac{h}{a}=g=\frac{8AEid}{bL'FL}\quad\text{for all cases.}$$

Deflection from steel elongation

$$D=\tfrac{1}{3}\frac{fL}{Eid}\times\frac{L}{2}\times\tfrac{5}{8}=\frac{5}{48}\frac{fL^2}{Eid}\quad\text{for uniform loads.}$$

$$D=\tfrac{1}{4}\frac{fL}{Eid}\times\frac{L}{2}\times\tfrac{2}{3}=\frac{1}{2}\frac{fL^2}{Eid}\quad\text{for central load.}$$

$$(8)\qquad D=\tfrac{3}{8}\frac{fL}{Eid}\times\frac{L}{2}\times\frac{11}{18}=\frac{11}{96}\frac{fL^2}{Eid}\quad\text{for equal loads at quarter points}$$

The total deflection caused by both moment and shear $=\Delta=D\,(1+g')$.*

Shear Resistance and Bond

External shear couples are directly opposed by fibre stress couples brought into action by the shearing resistance of the material between the centroids of compression and tension. Since this resistance sums or increases in the opposite direction as observed in the elastic prism from the fibre elongations and is proportional to the summation of the latter from mid span toward the end it cannot be proportional to the vertical applied shear as erroneously assumed in works on reinforced concrete and in building code rules of design. The correct equation governing this relation has been presented in *Concrete Steel Construction,* Eddy & Turner, pp. 180 to 185 as follows:—

$$\frac{1}{g}\frac{d^2h}{dx^2}=\frac{d^2a}{dx^2}=\frac{1}{EI}\frac{dM}{dx}=\frac{S}{EI}\qquad\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(9)$$

From this equation it appears that the second differential coefficient only of the horizontal shear distortion is proportional to the vertical shear stress.

Shear failure in the concrete beam is sometimes termed a diagonal tension failure made up of the stretching of the diagonal of the trapezoidal deformation combined with that of rhomboidal shear distortion. The former may be combined with the latter by treating the unit side of the square as the distance of the steel to the neutral plane. In this way the location of the greatest angular shear distortion or diagonal tension is found toward the center of the long shallow beam and toward the end of the relatively deep beam, just as experiment proves the case to be.

Wide divergence of shear resistance is manifested between the simple and restrained beam. In the latter rhomboidal distortion is zero at the support where the vertical shear is a maximum. It is greatest at the point of inflection.

There is consequently a wide difference in the shearing strength of the continuous or restrained beam and the simply supported beam of the same cross section.

The committee of the Concrete Institute are to be credited with pointedly calling attention to the wide variation of safe shear values although unfortunately their recommendations were empirical in derivation.

The value of shear and bond stress in works on reinforced concrete is given as follows:—

$$q=\frac{V}{bjd}\qquad\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(10)$$

$$u=\frac{V}{jd\,\Sigma_o}\qquad\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(11)$$

In which V=total shear, q=shearing unit stress, u=bond stress per unit area of bar, Σ_o=the sum of the perimeters of all the reinforcing bars.

By making the bond stress depend upon the vertical shear V the formula erroneously gives the maximum bond stress in continuous beams where it in fact passes through zero. While grossly in error for the continuous concrete beam it is inaccurate for the simply supported beam as well.

For uniform loading (steel in the bottom) $\frac{VL}{4}=f\,Ajd$

and we may substitute the value of fA in the formula for h from which

$$u=\frac{2}{3}\frac{V}{jd\Sigma_o}\quad\text{for uniform loads}\qquad\ldots\ldots\ldots\ldots\ldots(12)$$

$$u=\frac{V}{jd\Sigma_o}\quad\text{for concentrated central load}\qquad\ldots\ldots\ldots(13)$$

$$u'=\frac{3}{4}\frac{V}{jd\Sigma_o}\quad\text{for equal loads at the quarter points.}\qquad(14)$$

$$u=\frac{8}{9}\frac{V}{jd\Sigma_o}\quad\text{for equal loads at the third points...}\qquad(15)$$

Unit shearing stress (q) at the end of the beam may be determined from the value of h as follows:

$$h=\frac{q}{F}=\frac{2}{3}\frac{V}{jdbF}\qquad\ldots\ldots\ldots\ldots\text{for uniform loads.}$$

$$\text{hence, } q=\frac{2}{3}\frac{V}{jdb}\qquad\ldots\ldots\text{for uniform loading (16),}$$

and it thus appears that (10) gives values 50% greater than true values for uniform load but exact value for concentrated central loading and excessive value for all other cases.

*g' = g × coefficient representing the mean value of $\frac{h}{a}$

Let $p' = \frac{\text{steel area}}{bL'}$ and substitute in the formula for shear deflection and we may write:

$$\Delta = \frac{fL^2}{6E_s d} + \frac{2}{3}\frac{fp'}{F} \text{ for concentrated load at center.}$$

$$\Delta = \frac{5}{24}\frac{fL^2}{E_s d} + \frac{5}{6}\frac{fp'}{F} \text{ for uniform loading.}$$

$$\Delta = \frac{11}{48}\frac{fL^2}{Ed} + \frac{11}{12}\frac{fp'}{F} \text{ for equal loads at quarter points.}$$

$$\Delta = \frac{23}{108}\frac{fL^2}{Ed} + \frac{23}{27}\frac{fp'}{F} \text{ for equal loads at the third points.}$$

These equations present deflection from another angle and indicate to better advantage the relations of the resisting areas to the resulting deflection.

Standardization in Building Requirements

The United States Senate Committee on Reconstruction and Production, appointed in 1920, investigated the underlying reasons for high cost and inactivity in building industries in all parts of the country and found that "the building codes of the country have not been developed upon scientific data, but rather on compromises; they are not uniform in principle and in many instances involve an additional cost of construction without assuring more useful or more durable buildings." The committee considered that new drafts of codes could be prepared in the light of the collected experience of the whole country, and not as a result of purely local conditions. Another reason for the preparation of building codes which could easily be adopted as municipal ordinances is that 22% of the 1,478 cities and towns of over 5,000 population in the United States have no building code or inspector.

The Department of Commerce, under Secretary Hoover, organized, in May, 1921, a committee of experts to work on a national building code, which is intended to embody the opinions of the whole construction industry, backed by the technical knowledge of the Bureau of Standards. The committee is also to emphasize, through proper publicity, the advantage of revising the existing building codes in harmony with improved standards based upon the latest knowledge of materials.

The committee consists of Ira H. Woolson, consulting engineer, National Board of Fire Underwriters, New York City; Edwin H. Brown, architect, Minneapolis, Minn.; William K. Hatt, Professor of Civil Engineering, Purdue University; Rudolph P. Miller, Superintendent of Buildings, New York City; John A. Newlin, Forest Products Laboratory, Madison, Wis.; Ernest J. Russell, architect, St. Louis, Mo., and Joseph R. Worcester, consulting engineer, Boston, Mass. Frank P. Cartwright was appointed technical secretary, with a permanent office in Washington.

The general purposes of the committee are as follows:

1. To study existing building codes and determine the nature of their disagreement and the extent to which their requirements are oppressive to the building industry.

2. To gather information concerning minimum requirements considered essential by architects and engineers for safe and proper construction of buildings of different types and varying occupancy, in an effort to secure safe, economical construction and eliminate waste in building.

3. To prepare and publish recommended building regulations based upon the consensus of reliable information obtained through various channels of inquiry throughout the country, such recommendations to represent minimum safe practice in all matters pertaining to engineering design and general building methods. These recommendations to be drafted in such a form as to be easily adapted to amendments to existing building codes or adopted as ordinances.

4. To investigate the merits of new building materials and methods of construction which promise economy, and so far as it can do so legitimately to recommend such as have special merit.

It is not the purpose of the Committee to draft a complete building code. The main objects desired can be most quickly and easily secured by recommending standards of practice in that portion of the building code having to do with the construction of small houses. The shortage of 1,200,000 homes in the United States, according to reliable and conservative data, makes it apparent that if building regulations could be so modified and standardized as to effect even a small saving on each building without endangering its efficiency or permanency, a large total economy would result.

As a means for reducing construction costs in masonry walled buildings, strong appeals were made to the Committee for more generous recognition of 8-in. walls than they are now receiving in building codes of the country. The Committeee realized that marked difference of opinion existed on this subject, and above all that safety and efficiency must not be sacrificed for economy. It decided, therefore, to ascertain current practice in different parts of the country and to make a thorough investigation of the matter from every angle before offering recommendations.

A questionnaire was sent to a large number of cities and their requirements listed and carefully analyzed. A series of fire tests to be conducted under the supervision of the Bureau of Standards has also been planned, together with elaborate mechanical tests of the strength of brick walls in the largest units adapted to the 10,000,000 lbs. testing machine of the Bureau. Various minor tests and studies will also be performed in various parts of the country.

The committee has prepared a tentative report, which is being submitted to experts in various lines for criticism, after which it will be ratified and published.

Mixing Cement With Road Soils

Mixing cement with certain types of soils to alter the characteristics of the latter and make them more suitable for road surfacing and subgrades is an experiment recently conducted by the Bureau of Public Roads, Department of Agriculture, which now is proving its value in actual use. The treatment first was suggested and tried out at the Arlington, Va., experimental station of the Bureau. Results warranted a field test, and it was arranged with the California State Highway Department to try it on the adobe soil there.

A part of a Federal-aid project in Solano county was selected for the test. The dry soil was well broken up and harrowed to a depth varying from 6 to 12 in., and mixed with cement in the proportions of 1 part cement to 10 parts of soil and 1 part cement to 20 parts of soil. It was intended to water and roll the surface, but rain prevented. One section was allowed to remain untreated for purposes of comparison.

A recent inspection showed that the untreated section was broken up badly, due to the usual shrinkage cracks characteristic of adobe soils. The treated sections were in good condition and showed no shrinkage cracks. The treatment is not intended to make a hard surface like concrete, but to alter the properties of the soil so that it will be stable and lessen the effects of moisture. California plans to conduct additional experiments, which will be observed in detail by the Bureau of Public Roads, and cost data obtained.

Estimating the Cost of Plain Concrete Work

By Chas. F. Dingman, M. Am. Soc. C. E.

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There is hardly an operation in general building construction that is so unique that much that may be said of another operation will not apply to it as well. For this reason it is often necessary to master several different subjects before one may become really proficient in estimating the class of work covered by one subject.

While this present discussion of the method of estimating the cost of plain concrete will be rather lengthy, the reader must also thoroughly master the subjects of excavating, brickwork, reinforced concrete and timber framing, if he would get the best results in this particular work.

It is well to adopt a uniform procedure when surveying quantities for any kind of work, particularly so for concrete work.

The best method is to start at the beginning and list the different items in approximately the same order in which they will be constructed. Thus, wall footings, pier footings, walls, piers, etc. Also follow a regular system of setting down the dimensions, viz., length first, width or thickness second, and height third.

This method will always make it practicable to know just what each figure means and will also facilitate the calculation of form quantities.

It hardly seems necessary, at this late date in concrete construction, to stress the importance of carefully figuring all form work, either by the number of square feet of contact area or by the number of board feet of lumber to be used, and not by lumping the cost of form work into the cost of a cubic yard of concrete.

As a general rule, I use the contact area method because it gives very close results and is sufficiently accurate for all ordinary kinds of construction. For unusual work that would involve difficult, extra strong, or intricate form work, the design of the forms should be worked out before estimating and the cost carefully computed on the basis of the material to be used and the work to be done.

In scaling quantities for concrete work, I usually set my figures down in a form like this:

Plain Concrete Work

Wall Ftgs.
(2) x 32-0 x 2-8 x 1-0
(2) x 24-8 x 2-8 x 1-0
(2) x 6-0 x 2-0 x 1-0
4-0x x2-0 x 1-0

Pier Ftgs.
(4) x 2-6 x 2-6 x 1-0
(4) x 2-0 x 2-0 x 1-0

Walls
(2) x 30-10 x 1-6 x 9-0
(2) x 25-10 x 1-6 x 9-0
(2) x 6- 1 x 1-0 x 9-0

Piers
5- 0 x 1-0 x 9-0
(4) x 1-0 x 1-10 x 8-0

The figures in parentheses indicate that there is a plurality of items of like dimensions.

It is evident that the multiplication of the dimensions by each other (and by the figures in parentheses when there are any) will give the volume of concrete, in cubic feet, of each item, and the addition of the products will give the total volume; dividing it by 27, we get the quantity in cubic yards.

The calculation of the contact area of form work is equally simple and does not necessitate a new survey of the plans, provided the figures have been written down in the order specified.

For instance, two runs of footings, each 32 ft. long and 1 ft. thick, will require a line of forms on each side of each footing, and, except at the ends, the quantity of forms will not be affected by the width of the footing.

Therefore, multiplying the dimensions given, except the second, and doubling the product, will give the area of the forms required, except that allowance must be added for the ends of the form. In a case where footings of equal width abut, the saving of forms at the side will equal the form used at the end, and no calculation need be made.

Since pier footings and piers stand alone, it is evident that the forms extend entirely around them; therefore, the area of forms for any such footing or pier is twice the sum of its two horizontal dimensions multiplied by the height.

By following this same general method throughout it is possible to calculate the area of forms for any concrete work with very little labor. Discussion of the cost of form materials and labor will be given a little farther on.

Calculation of the quantities of materials required to produce a cubic yard of concrete is now reduced to the simple operation of referring to a table. Numerous such tables, in many varying forms, have been published, but the one which appears below is sufficiently complete for all ordinary uses. Most of the cement companies publish similar tables in handy pocket "calculator" form, and are glad to furnish them without cost to people having need of them.

This is about as wide a range of proportions as is found in ordinary building work, except cement finish

Table of Quantities of Materials Required to Produce 1 cu. yd. of Concrete in Place

In each column the quantities appear in the following order: Bbls. cement, cubic yards sand, cubic yards gravel or stone.

Nominal Proportions	1 in. Stone and under		Dust Screened Out		2½ in. Stone and under		Dust Screened Out		2½ in. Stone and under		Most Small Stone		¾ in. Gravel and under		Sand Screened Out	
1—2—3	1.46	0.44	0.89		1.48	0.45	0.90		1.53	0.47	0.93		1.34	0.41	0.81	
1—2½—5	1.19	0.46	0.91		1.21	0.46	0.92		1.26	0.48	0.96		1.10	0.42	0.83	
1—3—5	1.11	0.51	0.85		1.14	0.52	0.87		1.17	0.54	0.89		1.03	0.47	0.78	
1—3—6—	1.01	0.46	0.92		1.02	0.47	0.93		1.06	0.48	0.97		0.92	0.42	0.84	
1—3—7	0.91	0.42	0.97		0.92	0.42	0.98		0.94	0.42	1.05		0.84	0.38	0.89	
1—4—7	0.83	0.51	0.89		0.84	0.51	0.90		0.87	0.53	0.93		0.77	0.47	0.81	

work, but in reinforced concrete work it is often necessary to use much richer mixtures in columns or other places where great compressive strength is required.

Portland cement is always sold by the barrel, practically 3.8 cu. ft., and it is usually delivered in cloth sacks holding one-quarter barrel each. Delivery is sometimes made in paper bags of the same size, less frequently in wooden barrels, and occasionally in bulk carloads.

Sand, gravel and crushed stone may be sold either by the cubic yard or by the ton. Since the quantity of material to be used will be figured on the cubic yard basis, prices per ton should always be converted to prices per cubic yard.

It is always advisable to obtain the correct weight per cubic yard of any material which you propose to use, but in the absence of more definite information the following weights may be used:

Sand,	2700 lbs. per cu. yd.
Gravel,	2700 lbs. per cu. yd.
¾ in. crushed trap rock,	2600 lbs. per cu. yd.
1½ in. crushed trap rock,	2550 lbs. per cu. yd.
1½ in. crushed limestone,	2360 lbs. per cu. yd.
1½ in. crushed limestone,	2360 lbs. per cu. yd.
¾ in crushed granite,	2500 lbs. per cu. yd.
1½ in. crushed granite,	2400 lbs. per cu. yd.
Crushed slag,	2000 lbs. per cu. yd.

When figuring upon slag concrete, as a substitute for stone or gravel concrete, keep in mind the fact that you will probably need at least one-fourth more mortar in your mixture than you would to get a concrete of the same *consistency* with stone or gravel.

Whenever possible, it is well to get prices on all materials delivered directly to the site of the work. However, this is not always possible, and the information given here, and in a previous article on excavating (CONCRETE, Sept., 1922) will enable you to figure your own delivery costs.

A bag of cement weighs 96 lbs., for convenience in estimating it will be considered as 100 lbs., therefore, the load handled by a two-horse team will be about as follows:

On poor earth roads, 2,000 lbs. =	5 bbls. cement
On fair earth roads, 2,500 lbs. =	6¼ bbls. cement
On good earth roads, 4,000 lbs. =	10 bbls. cement
On hard surfaced roads, 6,000 lbs. =	15 bbls. cement

On level grades, the rate of travel will be two miles per hour with the load and three miles per hour with the empty wagon.

If you figure on the use of a motor truck, you can consider that it will carry its rated load and the speed will vary from eight miles per hour for poor roads up to twelve miles per hour for good roads. Trucks can operate at greater speeds and can carry more than their rated loads, but this is only at a greatly increased cost of maintenance.

The time required for loading, and the labor cost of loading, can be figured as follows:

From box car on to wagon, about one minute laborer's time per bag.

From ordinary cement shed on to wagon, one and one-quarter minute of laborer's time per bag.

Thus, with three men working, a load of 15 bbls. (60 bags) will require the wagon to stand for 20 minutes if loaded from the car and 25 minutes if loaded from the shed. If the force is larger, the time will be reduced proportionately.

Unloading will require three-quarters of a minute of laborer's time per bag if placed on a pile and one and one-quarter minutes if placed into the shed.

In figuring the cost of cement do not forget to make allowance for the bags. Cloth bags are usually charged for at 10 cents each, and credited at the same price when returned, charges prepaid, in good condition to the cement company's mill.

Since there is no way of knowing in advance how many bags will be lost or damaged on the work, it is good practice to figure on a loss of one bag out of each four; this figure also to take care of the cost of return freight and handling charges. Paper bags or wooden barrels are not returnable for credit.

When sand or gravel must be obtained directly from the bank, the cost of obtaining it can be figured as explained in the discussion on excavating, and due allowance must be made for the cost of stripping off loam or other worthless material. The bank should be visited and as careful a computation as is practicable under the circumstances should be made of the quantity of material to be stripped off, and this cost divided over the cost of the quantity of usable materials required from the bank.

It will seldom be practicable to use a "bank run" mixture of sand and gravel in concrete, but will usually be necessary to screen it to separate sand and gravel. Where it is practicable to set up the hand screen at the bank, an allowance of thirty-five minutes of laborer's time will be sufficient for each cubic yard of the bank run material.

The proportions of sand and gravel that any bank will produce can only be determined by test, and such a test should always be made when estimating on important work.

A word of caution may be added here. Quite frequently a bank of sand may be entirely suitable for concrete as far as may be determined by visual examination, yet a chemical analysis or a test of a sample of concrete made from the sand may disclose the presence of vegetable acids or other impurities that would make the sand unsafe for use. It is well to investigate this feature thoroughly when estimating.

When sand, gravel, or broken stone is purchased in carload quantities the following figures will govern; cost of carting from car to the work must be figured as previously explained and added to these costs. These figures are also to be used in computing the cost of moving material from a sand or gravel bank to the work.

Figures are given in hours of labor time, the waiting time of the wagon will be determined by its capacity and the number of men employed in loading. The waste time of the men will be determined by the number of wagons employed and their headway interval.

TIME IN LABOR HOURS

	From Ground to Wagon		From Gondola Car to Wagon	
	Wet	Dry	Wet	Dry
Sand	0.50	0.34	0.45	0.3
Gravel	0.65	0.47	0.60	0.4
Crushed trap rock		0.51		0.44
Crushed granite		0.49		0.42

Lost time of men and wagons may be reduced to a minimum by the use of unloading boxes, which are hung on the side of the car and into which the material is shoveled. When a wagon is to be loaded it is driven under the box, the contents dumped into the wagon, the wagon driven away and the box made ready to receive the load for the next wagon.

The reader who desires to pursue the study of mechanical methods of handling concrete materials will find much valuable and interesting material in Gillette's "Handbook of Cost Data," and Dana's "Handbook of Construction Equipment."

Mixing and Placing

Nowadays very little concrete in building work is mixed by hand, the usual practice being to use a gasoline machine driven mixer. Steam mixers are used in some cases, but they are coming into disfavor because of the need of having a skilled man—in many states he must be licensed—to take charge of the boiler and engine.

Electric motor driven mixers are also used at times, but they have not attained any great vogue.

Whether the mixing be done by machine or by hand, it must always be remembered that the number of yards of material fed into the mixer or on to the board will always greatly exceed the number of yards of concrete taken out.

For instance, 1:3:6 mixture, using 2½ in. stone and under with the dust screened out, will require for each cubic yard of concrete:

	0.93 cu. yd. stone
	0.47 cu. yd. sand
	0.15 cu. yd. cement
Total	1.55 cu. yd. material

which is the quantity that must be handled from stock pile or cement shed to the mixer.

Since this is dry material, the following figures may be used: One laborer can handle and move any of the following quantities of materials a distance of 40 ft. in one hour:

1.65 cu. yd. sand or gravel
1.71 cu. yd. crushed traprock
1.93 cu. yd. crushed limestone
1.78 cu. yd. crushed granite
2.22 cu. yd. crushed slag
40 bags portland cement

When the mixing is by machine, it is necessary to know the capacity of the mixer in cubic yards per hour for average running and the daily charge or rental rate of the mixer, as well as its consumption of fuel per day or hour.

Sometimes the capacity of a mixer is limited by a clause in the specifications which requires that the concrete be mixed for a given number of minutes before discharging, but usually the time of the mixer is determined by the ability of the machine to deliver well mixed product.

There are many records quoted ranging from a batch a minute upward, but it is hardly safe to figure on better than an average of 15 batches per hour for the usual run of concrete work in building.

Thus, if the mixer is a "one-bag" size it will turn out 15 batches of 6.42 cu. ft. of mixed concrete each (10 cu. ft. in-put each) when working on a 1:3:6 mixture, using 2½ in. and under stone with dust screened out. This equals 3.57 cu. yds. of concrete.

From the mixer, the laborers can each receive an average of 35 cu. ft. per hour and wheel it a distance of 40 ft. and dump it into the forms.

In addition to the number of men required to put the materials into the mixer and take the concrete away, allowance must be made for one man to tend the mixer, untie cement bags, etc., and at least one man to puddle the concrete into the forms.

With each increase of one bag in the nominal capacity of the mixer, one additional man will be needed for puddling and helping to dump concrete, and one extra man to assist around the mixer.

All of these statements apply to average conditions. When estimating careful attention must be given to all details to determine whether less favorable or more favorable conditions are likely to be encountered.

If the actual mixing is to be done by hand an allowance of 1.25 hours labor time must be included for each cubic yard of concrete. This covers the cost of doing the work that is done in the mixer and also the work done by the men tending the mixer.

To all of the above figures must be added the cost of a foreman and a waterboy. Their cost per cubic yard is found by determining the average production of the plant contemplated for the job under consideration.

The cost of water for mixing, while a small item, must always be included in the estimate, as well as the cost of connecting with the supply. Some cities make a flat charge per cubic yard of concrete, others require that the supply be metered and payment made accordingly. About 26 gals. of water are required for mixing a yard of concrete, but, including wastes, water used for sprinkling and other purposes, the actual quantity used on the job will be more nearly 100 gals. per cu. yd.

After the concrete has set and the forms are removed, it is usually necessary to smooth all exposed surfaces, erase form-board marks, and fill up hollow spots. Since the cost of doing this work is entirely dependent upon the care in building the forms and placing the concrete, it is a very difficult matter to determine the cost of finishing in advance.

However, the following figures may be used for all ordinary work:

Number of Square Feet per Hour

	Laborers	Masons
Cement-wash	20	
Brush-hammer (hand-work)		5
Crandalling (hand-work)		5
Picking surface (screen)	12	
Picking surface (hand	6	
Carborundum Rub	7	

Nothing has been said thus far about the cost of building runs for wheeling concrete. For ordinary plank runs the figures already given for moving concrete will be found large enough to take care of the usual amount of placing and moving.

Where the nature of the work is such that it will be necessary to build trestles or other special forms of rnus, they must be figured separately, as will be explained in the lessons on timber forming and on reinforced concrete construction.

Allowance must also be made for the cost of delivering equipment to the work and removing it at the completion. This is so variable a factor that it is difficult to give any rules for estimating. For instance, a small gasoline mixer may be so compact as to require practically no setting up after unloading from the car or truck, while a large steam mixer may require several days' labor in order to put it in running condition.

Cost of freighting equipment to and from the location of the work can be ascertained by inquiry of the carrier, and charges for unloading from car to truck and truck to car, or vice versa, will average about sixty labor hours per carload.

Since the equipment must be loaded and unloaded on both trips and must be freighted back to headquarters, a fair sized job will have to bear the expense of 240 hours' loading and unloading labor, trucking costs at both ends, both times, and freight two ways.

When cement is to be stored at the work, sheds must be built for this purpose, and, having determined the size necessary on the basis of the maximum amount to be stored, the cost of the shed can be estimated. Credit can, of course, be taken for the salvage value of the lumber after the shed is no longer required.

Form Work

Practically all forms for concrete work in buildings are now constructed of 1 in. boards, supported by 2 x 4 studs spaced from 12 to 24 in. apart, depending upon

the height to be supported on the load to be retained. Sometimes 1½ in. or 2 in. plank may be used for particularly heavy work or when so specified by the architect or engineer.

Since the usual method is to use 1 in. boards, we will base our present estimates accordingly, and the materials for 100 square feet of forms will be figured as follows:

Actual area of form	100 sq. ft.	
Waste for cutting, etc.	15 sq. ft.	
	115 sq. ft. of	
1 in. boards, or 115 ft. B. M., at $27 per M.		$3.11
Studs 10 pcs. 2x4—100	67 F. B. M.	
Allowance for waste, 15%	11 F. B. M.	
	78 F. B. M.	
78 F. B. M. Studs at $36.00 per M.		2.81
Nails (approx. 40 lbs. per 1,000 F. B. M.) 8 lbs. at 5c,		.40
Tie-wire (approx. 25 lbs. per 1000 F. B. M.) 5 lbs. at 6c,		.30
First cost of materials for 100 sq. ft		$6.62

The cost of labor will be governed largely by the class of men employed. For instance, if local conditions make it necessary to have practically all of the work done by carpenters, the cost will naturally be higher than where a large part of it may be done by "handy men."

On an ordinary job, where the laborers do all the handling of the lumber except the cutting, assembling, and nailing in the building of the forms and also assist in the erection, each 100 sq. ft. of forms, allowing an average of two f. b. m. of material per square foot, will require the following:

	Assembling	Erecting	Total
Footings			
Carpenters' time	2½	½	3
Laborers' time	1	1	2
Foundation Walls (first 10 ft. in height)			
Carpenters' time	3	1½	4½
Laborers' time	1½	1½	3
Each additional 10 ft. in height :			
Add Carpenters' time		½	½
Laborers' time		1	1
Piers (plumb sides)			
Carpenters' time	4	1½	5½
Laborers' time	1½	1½	3
Piers (pyramidal types)			
Carpenters' time	5	1½	6½
Laborers' time	1½	1½	3
Steps, Lintels, etc.			
Carpenters' time	7	2	9
Laborers' time	1½	2	3½
Slabs, Platforms, etc.			
Carpenters' time	6	1½	7½
Laborers' time	1½	1½	3

All of these figures are based on the assumption that the lumber will not be moved over 200 ft. from stock pile to its position in use. For greater travel add ½ hour laborers' time per 100 sq. ft. for each additional 100 ft. of travel.

After the concrete is hardened the forms must be stripped and cleaned if they are to be reused, or removed if they are of no further use.

For stripping, an allowance of 3 hours' laborers' time per 100 sq. ft. must be made.

When estimating the cost of forms for any concrete work, it is necessary to determine how many times the forms may be reused, if at all, and what value, if any, will be left in the form lumber at the end of the work.

If the forms can be reused, as when there are a number of members of the same dimensions, without any rebuilding, it is only necessary to figure the cost of material and of building the first time, and then to add the cost of stripping and re-erecting as many times as the forms will be reused.

If the forms are only used once, the lumber may have a salvage value of as high as one-third of its original cost, depending upon how much cutting up has been done, but when the forms are used more than once it is not wise to figure upon much resale value unless you have a certain place to dispose of the lumber.

Where the forms may be used again, but only after recutting and reassembling, it is not necessary to figure for new lumber again, but a new allowance of at least 15% for waste must be made and an allowance of ½ hour carpenters' time per 100 sq. ft. must be made to compensate for the slower work on the used lumber.

Sidewalks, Floors, Etc.

The following table, originally published by me in the Concrete for November, 1921, will enable you to compute quickly the quantities of materials required for any floor or sidewalk job.

Quantities of Materials Required per 100 sq. ft. of Floors, Sidewalks, Slabs, Etc.

Note.—Quantity of cement is given in barrels, aggregate in cubic yards.

Base Course

	1–2–4 Mix.	1–2–5 Mix.	1–2½–6 Mix.	1–3–6 Mix.
Cement	0.45	0.39	0.37	0.31
1 in. thick sand	0.34	0.12	0.14	0.14
Aggregate	0.28	0.30	0.28	0.28
Cement	0.90	0.79	0.74	0.63
2 in. thick sand	0.27	0.24	0.28	0.28
Aggregate	0.55	0.60	0.56	0.56
Cement	1.35	1.18	1.10	0.95
3 in. thick sand	0.41	0.36	0.43	0.43
Aggregate	0.83	0.90	0.85	0.85
Cement	1.80	1.57	1.47	1.26
4 in. thick sand	0.54	0.48	0.57	0.57
Aggregate	1.10	1.20	1.13	1.13
Cement	2.25	1.96	1.84	1.26
5 in. thick sand	0.68	0.61	0.71	0.71
Aggregate	1.37	1.50	1.40	1.41
Cement	2.70	2.35	2.20	1.89
6 in. thick sand	0.82	0.73	0.86	0.85
Aggregate	1.65	1.80	1.69	1.70
Cement	3.15	2.74	2.57	2.40
7 in. thick sand	0.96	0.85	1.00	0.99
Aggregate	1.93	2.10	1.97	1.98
Cement	3.60	3.13	2.94	2.51
8 in. thick sand	1.09	0.97	1.14	1.14
Aggregate	2.20	2.40	2.26	2.27
Cement	4.05	3.52	3.30	2.83
9 in. thick sand	1.23	1.08	1.27	1.28
Aggregate	2.47	2.70	2.54	2.55
Cement	4.50	3.92	3.66	3.14
10 in. thick sand	1.37	1.21	1.41	1.58
Aggregate	2.75	3.00	2.81	2.82
Cement	4.95	4.31	4.03	3.45
11 in. thick sand	1.50	1.33	1.55	1.56
Aggregate	3.03	3.30	3.09	3.12
Cement	5.40	4.70	4.40	3.77
12 in. thick sand	1.63	1.45	1.69	1.70
Aggregate	3.30	3.59	3.37	3.40

Top Course

	1–1 Mix.	1–1½ Mix.	1–2 Mix.	1–2½ Mix.
½ in. thick cement	0.75	0.59	0.50	0.43
Sand	1.12	0.89	0.75	0.64
¾ in. thick cement	0.18	0.21	0.23	0.24
Sand	1.12	0.89	0.75	0.64
1 in. thick cement	1.50	1.19	0.99	0.85
Sand	0.23	0.27	0.30	0.32
1½ in. thick cement	2.25	1.78	1.49	1.27
Sand	0.34	0.41	0.45	0.48
2 in. thick cement	3.00	2.37	1.98	1.69
Sand	0.45	0.53	0.59	0.63

	1-3 Mix.	1-1-1 Mix.	1-1-2 Mix.
½ in. thick sand	0.17	0.08	0.06
Cement	0.37	0.50	0.41
Aggregate		0.08	0.13
1½ in. thick cement	1.17	1.50	1.21
Sand	0.25	0.12	0.09
Aggregate		0.12	0.19
1 in. thick cement	0.74	1.00	0.81
Sand	0.38	0.15	0.13
Aggregate		0.15	0.26

1½ in. thick cement	1.17	1.50	1.21
Sand	0.50	0.22	0.19
Aggregate		0.22	0.38
2 in. thick cement	1.54	2.00	1.62
Sand	0.58	0.30	0.25
Aggregate		0.30	0.50

In addition to the necessary labor of handling the materials and mixing the concrete, the following labor must be figured upon:

Per 100 sq. ft. Finish

Carpenters setting screeds	0.4 hours
Cement finishers	3 hours

Per 100 lin. ft. Plain Base

Carpenters setting grounds	1.5 hours
Cement finishers	3 hours

Per 100 lin. ft. Sanitary Base

Carpenters setting grounds	1.5 hours
Cement finishers	4.5 hours

Be sure that you include all of the items of mixing, wheeling, hoisting, etc., that are involved.

When estimating floors or walks going on earth, be sure that you have an item in your estimate to cover excavating to the under side of the construction, and also any cinder or gravel course that may be specified.

For curbing, be sure that you include the cost of finishing top and face, also curb-bar, if specified.

Wakhiakum County, Washington, Court House

The picture shows the Wakhiakum county court house, Cathlament, Wash., built of reinforced concrete, Newton C. Gauntt, architect. The job was done by C. F. Martin, contractor. The building is 60 ft. by 60 ft. in plan; contract price, $36,213. Walls and floors are of reinforced concrete, floors are covered with linoleum. The roof is of red tile; the walls are finished outside with Atlas White cement wash and the building, facing

Court House of Reinforced Concrete Construction

as it does on the Columbia river, has given a great deal of satisfaction as a handsome structure.

Equipment Lease Out

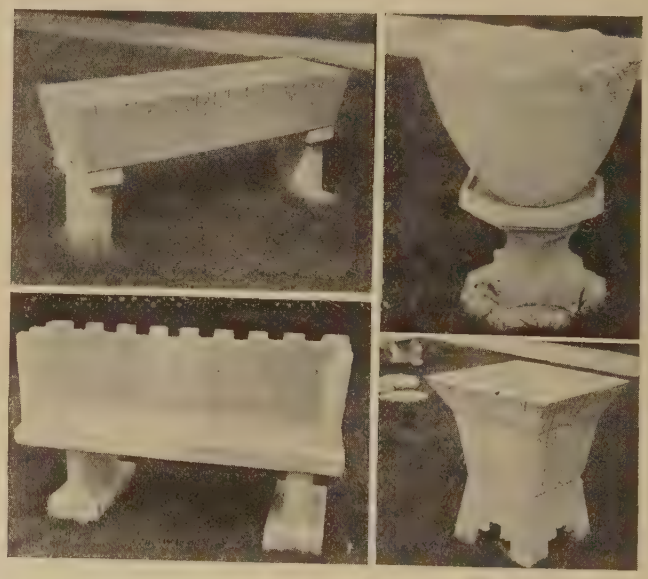
An equipment lease that constructors are willing to sign as either lessee or lessor has just been issued by the Associated General Contractors of America. Its object is to establish on a basis of common equity those obligations and responsibilities properly involved in renting construction machines, and to provide a simplified rental agreement which will insure absolute fairness to both parties. Thus a principal universally acknowledged and generally applicable, though too infrequently followed in the construction industry, will be given a practical test.

Result of Two Years' Preparation

The form adopted is the result of investigations and criticism of members of the A. G. C. extending over a period of two years. It was prepared under the direction of the Committee on Methods, of which A. P. Greensfelder, secretary of the Fruin-Colnon Contracting Co., St. Louis, was chairman, and Ward P. Christie, research engineer. Through use of this form it is believed that many difficulties incident to renting construction equipment can be eliminated.

The standard form is arranged so that all blank spaces for filling in of dates, rental rates and other stipulations are segregated on the front of a single sheet, and those provisions of general application and requiring no filling in for ordinary conditions are segregated on the back. Thus a concise form of letter size, convenient for filing, is afforded.

Copies may be obtained from the Associated General Contractors of America, 1038 Munsey Building, Washington, D. C., or through the secretaries of associated organizations, at 10 cents each, or $5 per hundred.



Concrete Products Surfaced While Green

The Concrete Products Co., Birmingham, Ala., R. L. Morrison general manager, is making a line of ornamental concrete, including urns, flower boxes, pedestals and benches, on which the finish is extremely informal and rustic. The products are cast to an approximate shape in plaster or wood molds, and when still green are carved and scratched to get the results shown in the illustrations. The mixture used is the same as the company employs in making its roof tile, a 1:2½ mixture of cement and sand. White cement is employed in all the exposed surfaces on ornamental work.

Floor Saves Pennsylvania College Building

By Prof. R. U. Blasingame
Department of Agricultural Engineering
Pennsylvania State College

A concrete floor in the attic of the Horticultural Building at the Pennsylvania State College saved the building from total destruction by fire on October 28, 1921.

This building is 60 ft. by 120 ft., and cost $120,000 in 1914. It houses the departments of horticulture, landscape design, rural life and many of the agricultural extension offices. The class rooms accommodate many of the rapidly growing courses in other departments of the agricultural school. In the attic of the building was housed the division of photography, and the newly installed research laboratory of agricultural chemistry. It was here that the fire started. It was purely accidental. One of the chemists was heating a flask of ether when the flask broke, and the flames from the burning chemical quickly spread to the thin partition walls and other wood material in the laboratory. Had these walls been constructed of fireproof material the fire might have been avoided entirely.

Soon after the fire began it was found that insufficient water supply rendered attempts to extinguish it futile. An illustration shows the anxious crowd in despair over the inability to save the building.

After the inflammable material from which the roof and laboratory equipment were built had burned out, the flames grew less until finally the fire went out of its own accord.

The condition of the warped steel rafters indicated very clearly the high degree of heat attained by the fire. On examination the concrete floor does not seem to be damaged in the least.

Fig. 1—Anxious College Folks Watch Fire Which Was Stopped by Concrete Attic Floor

Fig. 2—The Floor That Stopped the Fire

Fig. 3—The Condition of Steel Rafters Indicates Intensity of Heat

The total destruction of the building would have hampered the Agricultural School materially, owing to the fact that the other college buildings are already crowded to the limit, making overflow to them impossible. Many valuable records of an apple survey of the state and much experimental data might have been lost if the entire building had burned. Furthermore, the insurance would not have replaced the structure.

There is practically no damage to the three main floors except for smoke and a small amount of discoloring from water. Undoubtedly the concrete floors in this building were worth many times more to the College than the small investment which it took to install them. Without the concrete floors we would now be minus one of our best buildings.

The accompanying illustration shows a special arrangement for cleaning auto engine parts by steam. This consists of a concrete table, on which the engine parts are placed. A workman directs the steam on the parts, which cleans them of all dirt quickly. The water drains away through a pipe extending down through a concrete table. Steam is provided by means of a steam pipe which extends from the power plant at the pumping station near by. The steam at the table is controlled by means of a rubber hose.

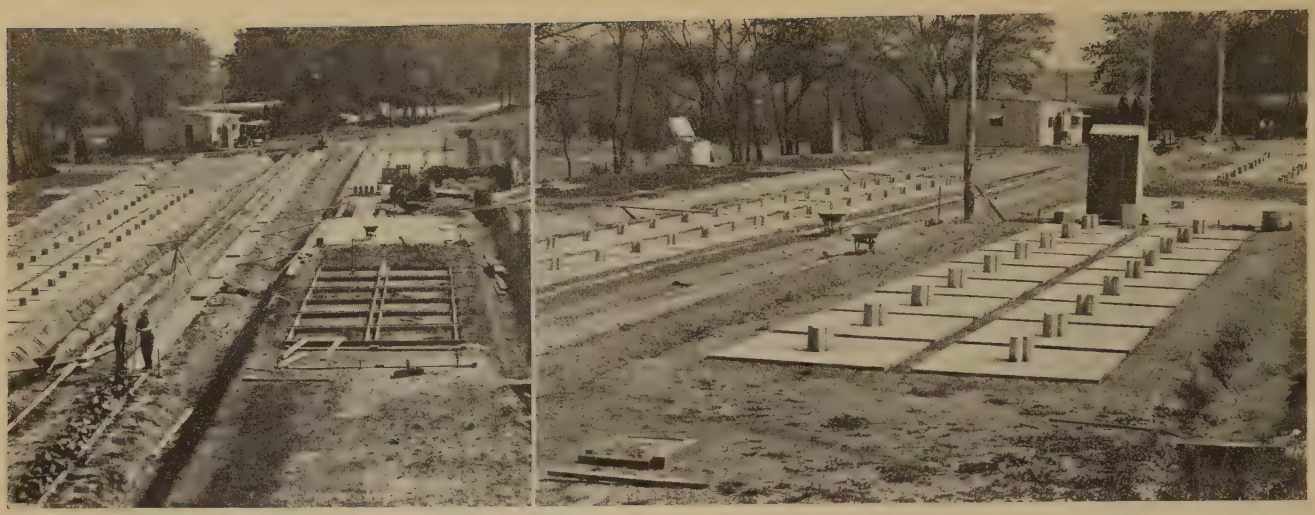


FIG. 1—(LEFT) GENERAL VIEW OF A PART OF THE ARLINGTON EXPERIMENTAL STATION, SHOWING SLABS FOR IMPACT TESTS, SECTIONS FOR CONCRETE WEAR TESTS, AND SLABS FOR THE INVESTIGATION OF MOISTURE AND TEMPERATURE EFFECTS

FIG. 2—(RIGHT) SLABS FOR IMPACT TESTS—THE CYLINDERS ARE FOR COMPRESSION TESTS BEING CURED UNDER THE SAME CONDITIONS AS THE SLABS

Experimental Road Work at Arlington to Continue

The Bureau of Public Roads is doing experimental road work at the Arlington Experimental Station, near Washington, D. C., in both concrete and bituminous wearing surfaces. The work on the bituminoush tops is to determine the reason for the formation of waves and irregularities and to settle questions concerning the proper mixture and the proper mineral aggregates to be used in bituminous roads. More than 30 sections of different types of bituminous construction will be built, including mixtures of different mechanical grading and with different percentages of bitumen of several degrees of hardness. Sections are being constructed on a circular track about 600 ft. in circumference, the roadway being 13 ft. wide. A 5-ton army truck will be operated over it, at a speed of from 12 to 15 miles an hour, until some results are obtained leading to the solution of the problems involved.

A wear test is also to be made with conditions approximating those actually found on the road. This test will include about 65 sections of concrete wearing surface, each section being of a different quality of concrete, the qualities being varied by virtue of the different aggregates used, different proportions in the mixture and amount of mixing water. These sections are to be constructed on a circular runway about 650 ft. in circumference, the runway being 4 ft. wide.

On this runway will be operated a specially constructed car with two truck wheels equipped with solid rubber tires guided by small railroad rails to hold it in position, the power being applied by means of an electric motor to the rear wheel. This apparatus will be operated around the circular runway at a speed of probably 20 miles an hour. The wheels will be equipped with different kinds of tires and the test will include the use of non-skid chains. A steel-tired wheel will probably also be used to get the effect of an accelerated wear test.

The effect of impact on concrete pavements and several types of road on concrete base was studied and reported on last year. This series of experiments is to be continued and enlarged. Over 120 road sections or slabs have been constructed in duplicate series. One series is on a carefully drained dry subgrade; the other series is on the same kind of subgrade, except that it is kept wet and as nearly saturated as possible by means of an underlying drain tile and side ditches filled with water.

The testing of these slabs will be by means of a new impact machine now being constructed, which simulates the action of the rear wheel of a truck. On this machine may be mounted truck wheels of different sizes and weights, carrying different kinds of truck tires. This apparatus may be so operated as to reproduce the different loading and equipment conditions of a large variety of trucks.

Subsoil investigations are being continued for the purpose of studying and investigating relative stability, moisture condition, and supporting value. Different methods of determining the bearing value of soils are also being studied, that is, as to whether small or large areas should be used in determining the relative bearing value.

The warping effect of temperature and moisture conditions on concrete pavements is also being investigated. In addition to these temperature and movement measurments, the pressures on the subgrade under the concrete slab are obtained by means of soil pressure cells.

The transmission of loads through different types of pavements to the subgrade is being investigated by means of soil pressure cells placed on the subgrade under the pavements. This test will also serve to show the relative support offered to brick and other types of block pavement by concrete bases and broken stone bases. This investigation has been under way for about one year, and will continue for some time to come.

Smith 7-S mixers, made by the T. L. Smith Co., Milwaukee, are now being furnished with rubber tires when desired. The fact that this type and size of mixer is used to such a great extent for city and town concrete jobs, such as building foundations, curbs, culverts, bridge approaches, etc., requires considerable transportation from one location to another. The rubber tires make the transportation easier and quicker, besides saving unnecessary jarring of the mixer.

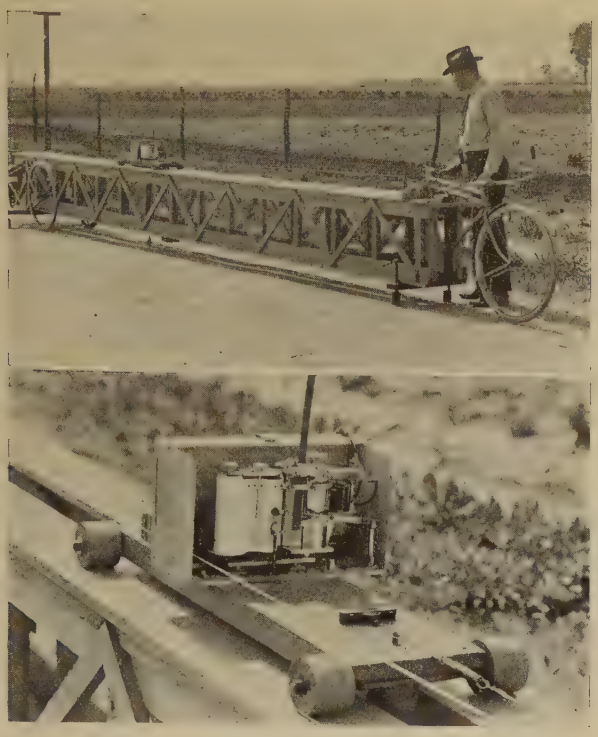


FIG. 1—THE PROFILOMETER, USED TO MEASURE SMOOTHNESS OF SURFACE OF BATES ROAD

FIG. 2—RECORDING DEVICE OF THE PROFILOMETER

Study Road Surface Irregularities[1]

It has been suspected for some time that roughness in a road surface is objectionable, not only from the point of view of those who travel over the road, but that it is also productive of damaging forces which affect the integrity and life of the road.

It is for this reason no less than for the accommodation of travelers that clauses have been inserted in modern specifications limiting the degree of roughness which will be permitted in the finished pavement. Such clauses, in fact, are inserted primarily with the protection of the road in mind, because the minor roughness which it is their purpose to limit is not particularly objectionable to the traffic.

But though there has been a well founded belief that such roughness does add to the intensity of the destructive force of impact, there has heretofore been no means of measuring the effect of it, nor has there been any instrument by which all the minor variations of surface level which make up roughness could be measured with accuracy.

Two instruments have recently been devised by the Division of Tests of the Bureau of Public Roads for the purpose of supplying this information in connection with the accelerated traffic tests which are being conducted under the direction of Clifford Older, chief engineer of the Illinois Division of Highways on the Bates Experimental Road. The two instruments are known respectively as a profilometer and an accelerometer.

The profilometer, which is to be used for measuring roughness, has just been constructed at the laboratory of the Illinois Division of Highways. By means of this device the profile of any part of the road surface can be quickly and accurately obtained. Aside from its use in highway investigations, it will be of particular value to all engineers engaged in highway construction since it affords a quick and simple means of determining if road surfaces conform to the degree of smoothness required by payment specifications.

The apparatus consists of a straight edge or track 24 ft. long and a recording device which, when drawn over the track, records accurately and autographically the profile of the pavement beneath. The track as used on the Bates road is supported by 3 bicycle wheels and consists of two wooden trusses 24 ft. long by 20 in. high, with a 3-in. space between them. Four turnscrews, two at each end, permit leveling the track at each set-up, while a piano wire under constant tension, stretched from end to end, gives a datum for detecting any sag in the track.

The recording apparatus consists of an American strainograph, to the pen arm of which is attached a rod connected with a brass wheel which rests on the pavement surface. The vertical movements of the small wheel, caused by irregularities in the surface, are traced on the recording paper by the pen. The instrument is mounted on a 1½-in. by 8-in. by 30-in. wooden platform, which rides over the trusses on four wheels, each 2½ in. in diameter and 2 in. wide. The platform is kept centered by two wheels which run in the 3-in. space between the trusses.

For drawing the recording device over the track, a wire cable is used attached to each end of the platform and passing over a pulley at each end of the trusses. The pulley at one end is operated by a crank.

In addition to the autographic record of the profile, the summation of the vertical ordinates of the surface profile can also be obtained from the profilometer by means of a special attachment which consists of a fibre strip ½ in. wide by 6 in. long, which receives the pen arm movement and operates against the recording wheel of a planimeter in such a way that the upward movement only is recorded. For convenience in securing the total of upward movements, a record is made at every ten revolutions of the planimeter wheel by breaking an electric circuit. The summation of vertical ordinates shown by the attachment divided by the length of surfaces passed over gives an average ordinate which can be considered as a roughness factor of the particular surface.

The rolls carrying the recording paper are driven by a pulley, which by contact with a cord fastened at each end of the track is caused to revolve as the platform is drawn along the track. Thus the paper on which the record is made moves a distance proportional to that traversed by the wheel on the pavement surface. The ratio of paper length to observed surface distance in this case is about 1:10.

This apparatus can be used to check up the smoothness of any length of pavement. As a first step levels are taken on points 18 ft. apart. The track is then set over these points and the recording apparatus is drawn over it. When these points are plotted on the profile paper the records can be placed directly on the points, thus giving a continuous and accurate profile of the surface for any required distance. One of the apparent advantages of the apparatus is the fact that the roughness can be determined accurately and in a comparatively short length of time. On the Bates experiment this apparatus has been used to determine the roughness of the surface before being subjected to traffic, as well as the effect of the traffic upon the surface.

The profilometer will be used also, in conjunction with the accelerometer, attached to one of the test trucks, for determining how roughness of the surface influences the impact of the motor wheel. The accelerometer, which was improvised by the Bureau of Public Roads consists of the recording part and case of an American Strainograph, to the pen arm of which is attached a rod supporting a weight suspended between two compression springs. This device is attached by means of rods

[1]Prepared by the Illinois Division of Highways and the Bureau of Public Roads.

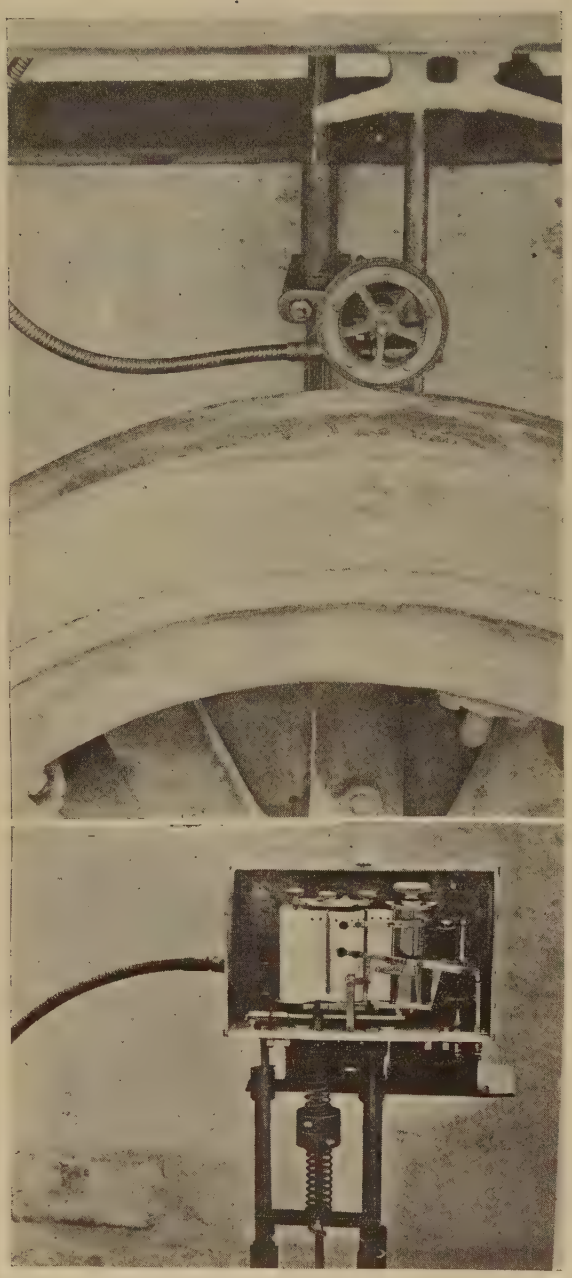


FIG. 3—ACCELEROMETER TO RECORD EFFECT OF ROUGHNESS ON IMPACT—AT TOP, THE ATTACHMENT TO REAR AXLE—BELOW, THE RECORDING MECHANISM

directly to the rear axle of the truck. In this apparatus also the recording paper moves a distance proportional to that passed over by the motor wheel, the roll carrying the paper being driven by a speedometer cable and a small rubber tired wheel, which rests against the brake drum of a rear wheel of the truck.

The theory of this device is simple. If there is no vertical acceleration of the axle, the weight will not change its position with respect to the axle and the record will be a straight line. Any vertical acceleration, however, will cause the weight and consequently the pen to vary from a straight line and the greater the acceleration the greater will be the variation from a straight line. This variation is a measure of the force which causes it and the force corresponding to any particular variation can be determined by calibrating the springs. Knowing this force and the mass of the wheel and axle it will be possible to compute the corresponding impact.

Having secured from this instrument the graphs showing relative impacts produced by different parts of the surface and from the profilometer graphs showing the roughness of these parts of the surface, a means results by which the effect of the surface roughness on the impact of motor wheels can be studied with a fair degree of accuracy. A study of the chart secured from these two instruments shows both the variation in the road surface and the effect of this variation on the moving motor truck wheel.

By means of the accelerometer it is intended to study the effects of surface variation on the rear wheel of a truck traveling at rates of 5, 10 and 15 miles per hour, with no load, and with 2½ and 5-ton loads. It will also be very interesting to determine the increase in wheel impact accompanying the increase of corrugations in the non-rigid types of pavement.

Oakville, Washington, High School

UNION HIGH SCHOOL, OAKVILLE, WASH., OF REINFORCED CONCRETE—NEWTON C. GAUNTT, PORTLAND, ORE., ARCHITECT

Full justice is not done by the accompanying illustration to the attractiveness of the Union High School at Oakville, Washington, built of reinforced concrete at a cost of $50,000 at war prices. The architect is Newton C. Gauntt, Portland, Ore. The contract was let to Coade & Stewart at $38,249 for the building and $11,000 for mechanical equipment, including heating, plumbing and electric wiring.

When these pictures were taken the grading and planting had not been done yet around the buildings, but still the structure itself is so attractive in its simplicity that tourists leave the highway in passing in order to look it over. It is reported that the state high school inspector said at the dedication of the building that it was the best laid out school of its kind in the state of Washington.

Mr. Gauntt, the architect, specializes in concrete and uses it in many buildings, not only for its serviceability, but for its economy.

The structural frame of the building is of reinforced concrete, exterior walls are likewise of reinforced concrete finished with a brush coat of white cement; even the columns at the entrance are also of concrete built in place. The roof construction, unfortunately, is of wood. This includes the wide, projecting cornice. Floors are reinforced concrete slabs covered with wooden finish. It is disappointing that mistaken ideas of community economy sometimes lead to the introduction of a very weak feature, such as a wooden roof, on an otherwise excellent structure, leaving it open to attack on its upper floor at least from fire.

Cutting Out Old Asphalt Top

The illustration pictures the use of pneumatic cutting tools in removing worn places in asphalt pavement surfaces, preparatory to repairing. This device is an adaptation of the pneumatic hammer perfected by Thomas H. Byrne, Superintendent of the Bureau of Streets, Chicago, Ill. The old hand method, necessitating prying up the pavement with a pick, made it necessary to cut back into the good surface in order to get a clean break. The pneumatic tool, giving a clean cut, saves at least 30% of the area, cutting down on the cost of the haul to the dump and the amount of new material. One machine can also do the work of three hand gangs. This department is equipped with two machines, mounted on motor trucks, which keep considerably ahead of the five repair gangs in the field.

Chicago Method of Cutting Out Defective Asphalt Paving

The defective pavement is cut out in blocks of about 1 sq. ft. and left in place until reached by the repair gang. In hot weather there is a tendency for these pieces to iron together. This can be prevented by sprinkling sand or dirt found along the street into the cuts.

Both Thor[1] and Dayton[2] hammers have been used and found equally efficient. A Zin-ho[3] air compressor is used.

A Portable Plant for Delivering Daylight to the Night Worker

In pushing concrete work through employment of night shifts adequate lighting facilities are an all important consideration. The emergency lighting equipment used by the Detroit Edison Co. in Detroit may be of interest to contractors.

In reality this equipment is a miniature power house on wheels, and the body of an old electric truck is used for supporting it. A complete generating set, consisting of a direct-current, 120-volt dynamo, direct connected to an air cooled engine, of 1 kilowatt capacity, is contained in the body. Suitable appliances for flood-lighting the working field are also supplied.

The flood-lights used have 15-in. reflectors and 250-watt lamps, and when the doors of the body are locked they are secured fast in their separate compartments. This insures them being ready for service when the job is reached and not all broken up. The reel for the wire is mounted in the front end and carries 3,800 ft. of twin conductor.

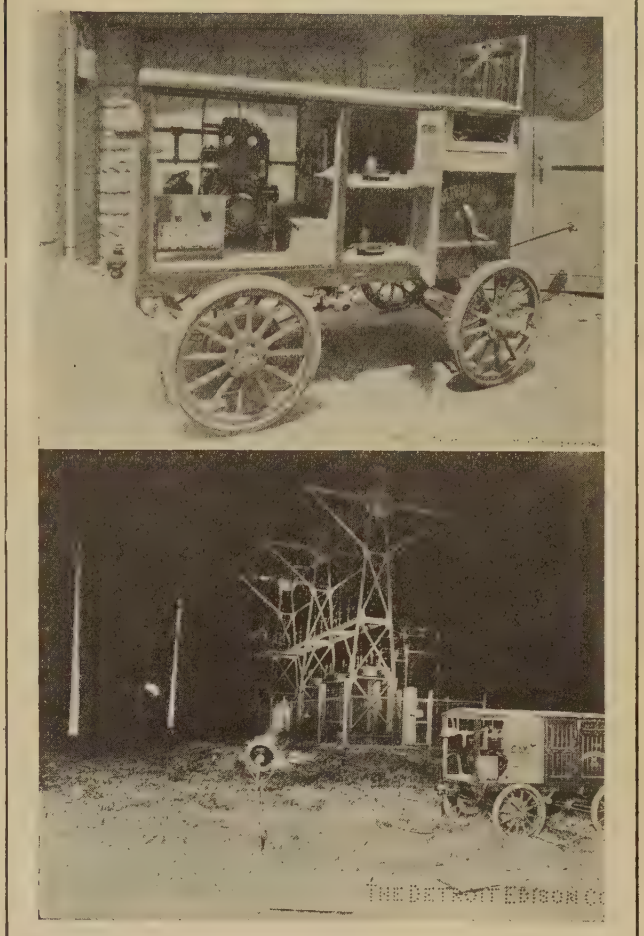


Fig. 1—The Arrangement Inside
Fig. 2—Lighting Equipment in Use

Every tool has a special place, and is kept there when not in use. A rear tank makes it possible to carry enough reserve gasoline for a 24-hour run.

Proper Mixture for Alkaline Conditions

The Colorado Agricultural College receives many inquiries from builders or individuals regarding the proper mixture of concrete for work under strongly alkaline conditions. The College gives several general precautions to be observed under these conditions. Water used for mixing must not contain any alkali. The newly placed concrete must be protected from coming in contact with the alkaline soil and soil water as long as possible, but at least three weeks. This is accomplished with tar paper, cinders, forms in building the work. A 1:2:3 mix of concrete, well mixed for at least 1 minute and kept wet or damp ten days after pouring with clean water should be used. Scores of concrete bridges and other concrete structures in the Arkansas valley and in the Uncompahgre valley, on the western slope, where very strong alkaline conditions exist, stand year after year with few or no signs of injury.

[1]Independent Pneumatic Tool Co., Chicago, Ill.
[2]Dayton Pneumatic Tool Co., Dayton, Ohio.
[3]Mundie Manufacturing Co., Peru, Ill.

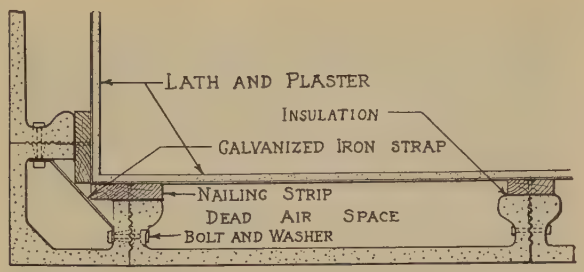


FIG. 1—HORIZONTAL SECTION OF WALL BUILT OF CONCRETE LUMBER

A California Concrete Lumber

A new concrete "lumber" development, tested since 1918, is reported from California. The material may be had in various lengths, thicknesses and shapes, suitable for buildings large and small, of light or heavy construction—warehouses, factories, bungalows, garages, etc., and it is said also for irrigation ditches, culverts, dams and sea walls.

Fig. 1 shows its use in light wall construction. Concrete is poured over woven steel-wire on wood forms (Fig. 2), these forms giving the tongue and grooved edge, like that of common lumber, through which the boards or parts are bolted together with steel shackles, making anti-friction joints. The base is a mixture of cement and sand, in a 1:4 mix, without the addition of rock. Any desired shapes are cast, but all are uniformly of inch-thick concrete. A month is allowed for the hardening of the product, first under wet burlap, then in the open (Fig. 3).

Two trucks carried the complete material for a 5-room bungalow for forty-five miles without so much as chipping an edge. The manufacturers say it provides earthquake-proof construction. Construction details are shown in Fig. 4.

FIG. 2—FILLING THE MOLDS

FIG. 3—CURING YARD

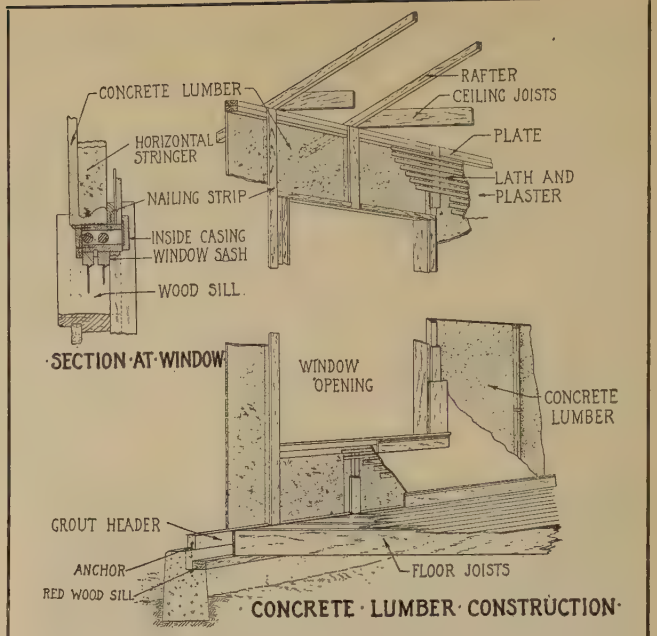


FIG. 4—CONSTRUCTION DETAILS WITH CONCRETE LUMBER

Pneumatic tools are used to cut through the steel and concrete wherever necessary, though little cutting is needed, as standardized shapes and lengths are at hand for all quick construction.

The cost, it is said, does not exceed that of frame and stucco, for while the material may be slightly in excess, no high-priced labor is required and much time is saved. It is proposed to make the lumber with various surface colors and textures or coat exteriors with gunite.

In 1918 a sea wall 1,706 ft. long was put in at Long Beach, Cal. The precast slabs were made under the Henry Schlueter patents used by the Concrete Lumber Co., which is producing the concrete lumber at Los Angeles. For the sea wall the slabs were placed in an inclined position, replacing an old vertical wall. The plant has a capacity of 10,000 sq. ft. a day.

Engineers' Registration Board Meets

Reciprocal registration of engineers was considered by the Council of State Boards of Engineering Examiners, which recently met in Chicago. This board consists of a representative from each state board, but in many cases it was expected that the entire state board would attend this important meeting.

A tentative plan was submitted at the meeting whereby the several state boards could make operative for reciprocal registration the several state laws without changing the laws, which would be a long and uncertain procedure. A solution of reciprocity between the states which would permit a man registered in one state to practice in other states will mean much for the public and the engineering profession.

If you have a good idea—something you learned on the job—pass it on to "the other fellow".

Cinder Block Fire Tests

Fire tests by the Underwriters' Laboratories, Chicago, of hollow cinder concrete block have just been reported on, with final recommendations by the Laboratories, and show most interesting results, which go a long way to bear out the claims made for the material by the owners of the system—Crozier-Straub, Inc., New York City.

These tests also add interest to a series of fire tests of concrete building block for which preliminary work is under way by Committee P-5 on Fire Resistance of Concrete Building Units of the American Concrete Institute—tests to be made this winter by the Underwriter's Laboratories.

The cinder block tests were made on two panels, 28 and 29 days old, fire test walls being 10 ft. and 11 ft. high. One panel was submitted to a fire endurance test; the other to a fire and hose stream test. In their report the Underwriter's Laboratories describe the panels, one of which was built in two hours and 30 minutes, the other, in two hours and 33 minutes, block having been laid up by F. J. Straub himself, with two Laboratory assistants. The general appearance of the wall was that of having been built without special attention to neat appearance, but probably representing the average conditions in installations where speed in erection is desired. All blocks were laid with cells vertical, joints

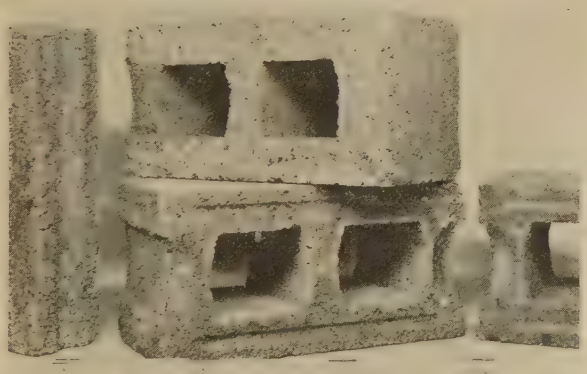


FIG. 1—TYPICAL FORMS OF BLOCK

broken, only full size and half size block being used. Block which did not fit snugly were trimmed with a small hatchet. The mortar was made of 1 part portland cement with 3 parts lake sand and about 8% slacked lime, all measurements being by volume. Enough water was employed to make a thin mortar. In laying the block no mortar was applied to the webs, and no special effort made to apply the mortar uniformly. Joints which were apparently not well formed were subsequently smoothed.

In the fire test the exposed face of the panel was subjected to standard fire test conditions, in which the temperatures rise rapidly to 1,500° F. during the first 30 minutes, and to approximately 1,700° F. in one hour, and continue to rise gradually until the end of the test, which was continued for 3 hours and 42 minutes, after which the fire was extinguished and the test panel immediately drawn away from the furnace and allowed to cool. The report records that at the end of 25 minutes the upper half was slightly warm to the touch; in 35 minutes the lower half. At 2 hours 15 minutes incandescent material could be seen at two vertical joints; after three hours a similar incandescence was observed at four additional vertical joints. The temperatures on the unexposed face, in the cells and in the inner surface of the exposed walls of the cells and in the mortar joints were taken. On the unexposed face one thermometer indicated 300° F. at two hours 58 minutes. The average reading of five thermometers was 300° F. at three hours 15 minutes. After the furnace fire was extinguished at three hours 42 minutes, the panel was withdrawn and the temperatures on the unexposed faces continued to increase to a maximum of 500° F. in four hours 25 minutes. At the end of the test, after complete cooling, the panels showed no cracking, spalling, or other structural damage. In the fire and hose stream test the sample panel was subjected to the standard fire test for 60 minutes. It was then drawn away from the furnace and a 2½ in. hose stream was applied to the heated face for five minutes. The stream was applied from a position 20 ft. distant and opposite the center of the panel. It was directed first at the center and then at all points of the exposed face changes in the direction of the stream being made slowly. Pressure at the base of the nozzle was 50 lbs. There was no spalling nor other structural damage to the wall, no blocks were displaced. The maximum amount of erosion occurred slightly above the center line, where on two blocks material had been washed away to a depth of 1¼ in. Erosion was rather general, but not uniform. The stream washed away some of the mortar in the joints, and formed one through opening, ¼ in. wide and 8 in. long, between two blocks in the north quarter. No other through openings were formed.

Absorption Tests

To indicate the kind of block which were used in the fire test, various other tests were made. Twelve blocks selected at random from a shipment of 700 blocks were tested for absorption. They were first dried in a temperature of 175° to 200° F. and weighed, then immersed in clean water for 72 hours. After immersion the surplus water was wiped off and the block was reweighed. The gain in weight on the 12 blocks averaged 21%, ranging from a minimum of 16% to a maximum of 25%.

Compression Tests

Compression tests were made on four months' old block, which had not been subjected to any previous test. Full size hollow blocks showed a minimum compressive strength of 650 lbs. per sq. in. in gross sectional area, a maximum of 1,140 lbs. and an average of 815 lbs. This figures out as a minimum of 880 lbs. and a maximum of 1,150 lbs., and an average of 1110 lbs. on the net area. Solid block showed a minimum of 1,150 lbs., a maximum of 1,560 lbs., and an average of 1,270 lbs. per sq. in. Compression tests on saturated block, each block being immersed in clean water for 48 hours, gave the following results on an average of five blocks: maximum gross cross sectional area, 825 lbs.; minimum, 530 lbs.; average, 665 lbs. Net area: maximum, 1,120 lbs.; minimum, 725 lbs.; average, 910 lbs.

Freezing and Thawing

Five hollow block, full size, were immersed in water until saturated, placed out of doors in temperatures of 10° to 20° F. for 24 to 48 hours, and allowed to thaw in a water bath at 60° F. Freezing and thawing

FIG. 2—FIRE ENDURANCE TEST—EXPOSED FACE OF WALL BEFORE TEST

FIG. 3—FIRE ENDURANCE TEST—UNEXPOSED FACE OF WALL BEFORE TEST

FIG. 4—FIRE ENDURANCE TEST—EXPOSED FACE OF WALL AFTER TEST

FIG. 5—FIRE ENDURANCE TEST—UNEXPOSED FACE OF WALL AFTER TEST

processes were conducted five times with each block. The block were then dried to constant weight and tested and showed strengths for gross area: maximum 900 lbs., minimum 570 lbs., average 715 lbs.; for net area: 1,230 lbs. maximum, 775 lbs. minimum, 975 lbs. average. Five full size hollow block were immersed in water until saturated, dried to constant weight, and after three successive saturations and thawings gave the following compression strengths: gross area, 940 lbs. maximum, 580 lbs. minimum, 750 lbs. average; net area, 1,280 lbs. maximum, 790 lbs. minimum, and 1,025 lbs. average.

Five blocks removed from the test wall, which had been subject to the fire and endurance test, gave the following strengths: gross area, 585 lbs. maximum, 485 lbs. minimum, 545 lbs. average; net area, 800 lbs. maximum, 660 lbs. minimum, 745 lbs. average.

FIG. 6—FIRE AND HOSE STREAM TEST—EXPOSED FACE OF WALL AFTER TEST

Five blocks used in the fire and hose stream tests showed compressive values as follows: maximum 785 lbs., minimum 595 lbs., average 690 lbs.; net area, maximum 1,070 lbs., minimum 810 lbs., average 940 lbs.

An impact test was made on the test panel which had been subjected to the fire and hose stream test, six days subsequent to the fire test. The movable wall, carrying the test panel, blocked so that it couldn't swing, was placed to receive the impact of a steel and concrete member 16 ft. 6 in. long, weighing about 2,500 lbs., mounted vertically on a hinged base designed so that when released it would swing in a vertical arc with its hinged base as a center, the upper end of the member striking about the center of the test panel. The general effect of the test was intended to be representative of the impact of structural members falling against a wall during or after a fire. The first impact ruptured blocks locally so that a through opening was formed about 20 in. high and a width equal to the swinging member, or 15 in.; the second impact enlarged the damaged portion to a total of five courses high and 16 in. to 18 in. wide. The stability of the wall as a whole was apparently not impaired.

CONCLUSIONS

The Laboratories' conclusions are given in full as follows:

FACTORY METHODS

Information contained in this section was obtained by a representative of the Laboratories during an inspection at the plant of the York Patented Building Block Co., York, Pa., during the manufacture of the blocks that were employed in the investigations described in the examination and test record.

Ordinary run-of-boiler soft-coal cinders were crushed and mixed with portland cement in the proportion of 6 parts cinders to 1 part cement by volume. Water was added without measuring, and the batch mixed by means of hand tools. The wet concrete was transferred to the forms of a hand-power block machine. Each block, after removal from the machine, was allowed to cure from four to six days, water being sprinkled on the block two or three times daily.

FIRE RETARDANT PROPERTIES

Straub cinder concrete blocks constructed of the materials and by the methods described in this report, can be employed for the construction of exterior or interior walls, bearing or non-bearing, which when exposed to fire on either side will prevent the passage of flame through the wall and function as a barrier to the spread of fire by heat conduction for at least 2½ hours. Application of a hose stream to either side of the wall during the first hour of fire exposure will not seriously impair its fire resistance.

No flame passage occurred during the fire endurance test, and no through openings were found. The critical temperature of 300° F. was reached on the unexposed face at 2 hours 58 minutes.

PRACTICABILITY

The blocks may be shipped in bulk without material injury. They may be handled without difficulty and installed rapidly by any competent bricklayer using ordinary tools.

In a half carload shipment of the blocks from York, Pa., to a Chicago freight house, and thence by truck to the Laboratories, the amount of damage to the blocks was negligible.

Each of the two 10 by 11 ft. test walls erected by the Laboratories was completed in about 2½ hours.

DURABILITY

The blocks are capable of withstanding long-continued exposure to weather conditions without material deterioration.

Specimen blocks were subjected to a rather extensive series of tests involving saturation, freezing, thawing, and drying. No visible deterioration was caused by any of these tests. Compression tests made on blocks subjected five times to saturation, freezing and thawing and then three times to saturation, and drying, showed an average crushing strength of 750 lbs. per sq. in., and a minimum of 580 lbs. per sq. in., of the gross sectional area. These values may be compared with the average of 815 lbs. per sq. in. and the minimum of 650 lbs. per sq. in. in the case of blocks that had not been saturated. It is believed that these differences are not significant in view of the characteristic variations in compressive strength commonly shown by tests of concrete products.

STRENGTH

The strength of the blocks is sufficient to warrant their use in bearing or non-bearing walls, within the limitations commonly recognized as applying to materials of this character.

In general concrete blocks are considered suitable only for buildings of moderate height, and with types of floor construction and of occupancy that will impose loads on the walls well within safe limits for Straub blocks.

It is believed that there is not thus far any generally accepted specification regarding the crushing strength of cinder concrete blocks. The building code recommended by the National Board of Fire Underwriters states that "the average compressive strength for concrete blocks when tested with the cells vertical shall be not less than 800 lbs. per sq. in." The blocks forming the subject of this report had an average crushing strength of 815 lbs. per sq. in.

The effects of the impact test were purely local.

UNIFORMITY

The blocks can be produced commercially with the degree of uniformity sufficient for the purposes for which the material is intended.

The dimensions of the blocks are determined by the dimensions of the forms in which they are cast. The density and the compressive strength are subjected to variation within rather wide limits. In the case of the blocks employed in the examinations and tests described in this report, all being the product of the same plant, examination of 12 blocks showed weights varying from 16% to 25%. Compression tests showed ultimate crushing strength varying from 650 lbs. to 1,140 lbs. per sq. in. of gross sectional area. The cinders employed in the mixing of the concrete were of rather inferior grade, wth 18% to 19% combustible material, the presence of unburned coal or coke being evident on visual examination. Approximately 40% by weight of the cinders passed a 20-mesh sieve. The results of the tests made on blocks employing this inferior aggregate and a rather small proportion of cement, were so favorable, notwithstanding the variation in some important properties, as to justify the opinion that the variations noted are within permissible limits.

Small vs. Large Reinforcing Bars

By Charles E. Reynolds
Kingston-on-Thames, England

A decade ago the detailer of reinforced concrete was governed by the maxim that steel reinforcement consisting of several small bars is preferable to that involving the use of a few large bars. From the theoretical standpoint this may still be regarded as the best judgment of many engineers, but there are those however, who are among the users of loose bar systems, who prefer to obtain their required area of steel by the use of a few large bars as opposed to several small bars, a course which is held as more economical by those who adopt it. Advantages are naturally obtained by the use of either of the systems, a comparison of which it is here proposed to make. It will be assumed that ordinary commercial rounds are used in either case.

Consider the subject from the designer's standpoint. With large bars, he has longer lengths available, and their use implies a reduction in the number of laps required, and avoidance of possible congestion of steel due to many overlaps. At the same time however, most designers are agreed that a more uniform resistance obtains throughout a section reinforced with bars close together, as is the case when small bars are used. Further, with a given depth of beam or slab, a slightly larger lever arm is obtained and hence a little less steel may be necessary, the area of which may be possibly more closely obtained by the use of small bars, since the interval between the areas obtained at practicable centres is smaller than with large bars. Less adhesion length per bar is necessary while smaller, and quite as effective, hooks and bends are required for small bars. In beam detailing the latter enables more bars to be bent up at convenient points for shear resistance, than is possible with the use of a few large bars.

From the contractor's point of view, however, it would seem that larger bars should be favored.

Although larger bending and cutting machines may be required (though it is usual to have a variety of sizes on the site) and fewer bars can be handled at once, larger bars are cheaper to buy and are usually more expeditiously obtained, while labor costs are also cut by their judicious use. There are fewer bars to bend and fewer to handle. Their rigidity makes steel placing easier and there is much less misplacement through whippiness, nor are extra stiffening bars required. Distortion due to transit, or being trampled on by workmen is also avoided. Small bars are naturally easier to cut and bend (whereas large bars may require heating before bending), and can be bent when in position by hand-benders, but if left exposed for any length of time (which does occur despite specifications requiring the covering with cement wash of all exposed steel) pitting with rust more seriously reduces the effective area of each individual rod.

It is a foregone conclusion however, that the subject resolves itself into a contest of theory vs. practice, and since the latter is in this case the economical standpoint (assuming of course that theory is not disregarded sufficiently to imperil the safety of the construction) the large bar system undoubtedly appears to be the more advantageous. A great deal depends on what structural member is being considered.

In slab construction the advantages accruing from the use of small bars may to a certain extent be obtained by the use of mesh or lattice reinforcements, but the controversy (if such exists) between the use of these patent methods and the loose bar type, is outside the province of this article. Confining our attention, however, to loose bar systems, consider the case of a slab 4 in. total thickness requiring .23 sq. in. of steel per foot width. This would be provided by either 5/16-in. diameter bars at 4 in. centre to centre, 7/16 in. at 8 in., or ½ in. at 10 in. centers. Various regulations govern the extent to which the principle of using as large size of bar as possible can be applied. Thus the London County Council specify that the maximum spacing shall not exceed twice the effective depth. In a 4 in. slab having an effective depth of 3.25, the maximum spacing would be 6½ in., thus automatically fixing the size of bar at ⅜ in. diameter. In some respects the L. C. C. regulations are admittedly somewhat old-fashioned, and more economical would be ½ in. reinforcement at 10 in. centers in case where the main reinforcement is along both axes of the slab, or 7/16 in. at 8 in. centers, where it is in one direction only, with an efficient distributing system of light steel at right angles. The New York regulations would allow either of these sizes and spacings.

The sizes of main bars in beams are settled largely by the size (especially the width) of the beam. In small members to have a minimum of two bars in the bottom (although efficient detailing obtains by the use of one bar in top and bottom, as in light trimmer beams), is common, and when the number is thus specified, the size of the bar is automatically fixed, with usually ½ in. as a minimum diameter. In large beams a few larger bars are usually more convenient, as the comparative width of beam is not so great, and would probably necessitate two layers of small bars with consequent loss of lever arm and increased constructional difficulties. Large beam bars allow more ample space between them, allowing more efficient ramming of concrete.

It is common knowledge that stirrups or beam bindings are expensive items to bend, and anything that can be done to decrease their number is worthy of consideration. Limitations are imposed for theoretical reasons on the spacing of these shear members, and it is a moot point whether it pays to alter the sizes of the bindings in order to attain the maximum spacing (usually the lever arm), and thus reduce the number of bindings to a minimum. Something in this direction may be done when the bulk of the shear can be taken on bent-up bars, and only a nominal amount left to the binding, which method produces a very economical design.

The main bars in columns are more or less fixed in number and hence their sizes are determined. Here, however, where four bars can be made to supplant six or eight smaller bars, the number of bindings are halved, as it is usual for one binder to secure four longitudinal bars only. In columns much scope is found for the application of the large bar principle. It is the opinion of many engineers, however, that the criterion of the strength of a direct compression member lies in the hooping and binding, and pursuing this idea, it follows that small expensive binders at close centres give a stronger member. If this view is held, spiral binding is found to be cheaper, but in light columns where such binding would not be economical the spacing should be as large as possible, up to a maximum equal to the effective width of the column.

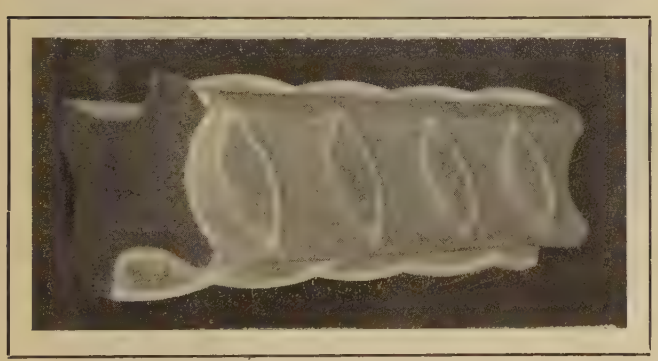
It is contended from these few remarks that, without extensively violating theoretical principles, that more economy accrues from the use of a few large reinforcing bars, than from an equal amount of steel, contained in several smaller bars.

HEIL SWING PARTITIONS FOR DUMP TRUCK BODIES

Swinging Partitions for Motor Truck Dump Bodies

Swinging partitions for motor truck dump bodies that make it easy to handle concrete road building materials in batches or mixes are now manufactured by the Heil Co., Milwaukee, Wis. They are easily operated by one man by means of a lever, attached to an eccentric roller operating in a bearing, which raises the partition vertically until it clears lugs on the bottom of the body. When the body is raised the partition swings outward, allowing the compartment to be emptied. Bodies can be fitted with as many partitions as desired by bolting the eccentric bearing to the sides with two bolts which can be removed, making the body a standard dump.

The Royce Deformed Bar



The Royce patented reinforcing bar, a section of which is shown in the accompanying illustration, is soon to be placed on the market. It is a deformed bar of sectional areas conforming to plain rounds and squares. The body of the bar is substantially a square with rounded corners, and with concave depressions on the faces. The metal taken from the sides of the square is used to form the lugs which are distributed in a manner designed to give a bar of constant sections and maximum strength.

Among the advantages claimed for this type of bar are: No sharp corners to cause cracks, all faces being either concave or convex; maximum of bond for a given weight of metal; relatively small space required in concrete mass; no special position in regard to deformations in which it must be placed, since metal is uniformly distributed, producing a bar of equal strength in all directions.

Placing Concrete With Belt

The use of belt conveyors in placing wet concrete was described in an article in the October, 1921, issue of CONCRETE, the information having come from the Barber-Greene Co., Aurora, Ill., whose conveyors for this purpose are further illustrated here, as used in placing wet concrete on a large sewer job.

Replacing the wheelbarrow gang with a Barber-Greene portable belt conveyor, the Walbridge Engineering Co., 1014 South Michigan Avenue, Chicago, Ill., are reported to have speeded up their work and reduced the men required from 27 to 10.

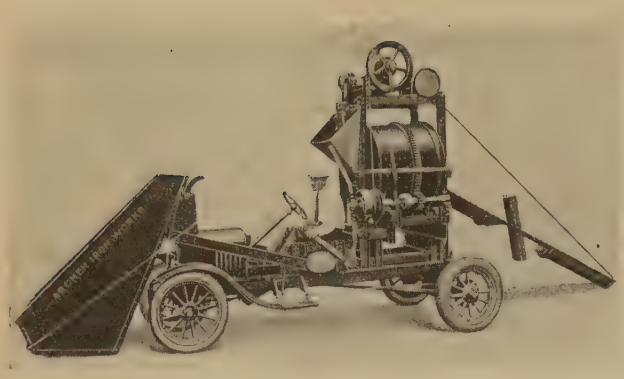
The form shown contains 37 cu. yds. of concrete, placed in two hours with the conveyor. No particular attempt to produce an especially dry mix was made, as it was found that the belt would carry concrete of any consistency. In fact, after the first form had been poured, the belt was doused with water to clean it. The belt even carried the water up the incline and discharged it as it had the concrete.

The conveyor is equipped with an 18-in. rubber belt running on troughing carriers. A simple wiper and spout have been added at the discharge end. The spout catches all the concrete and discharges straight down, to avoid segregation of materials in the mix. Concrete is discharged directly from the mixer into the hopper end of the conveyor, as shown in Fig. 2.

On a somewhat similar job by the Walbridge Engineering Co., a track was laid parallel to the line of work, and a flat car pushed along on the track. On the car the mixer was mounted at a height which made it possible to chute the wet concrete to the forms by gravity.

The wheelbarrow gang pushed all the sand and gravel up grade to get it onto the car, and several men were required to take up the track and lay it ahead of the car. E. J. Gaylord, superintendent on the job, while frankly skeptical as to the ability of the conveyor to carry the concrete, found in actual use that it proved to be entirely practical and efficient.

BARBER-GREENE BELT CONVEYOR PLACING CONCRETE

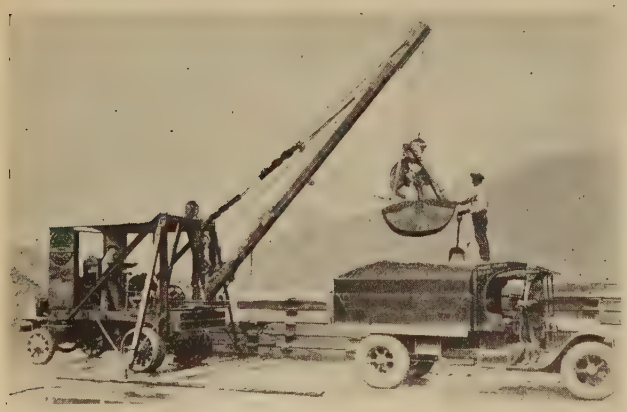


Ford Mounted Mixer

Mixer equipment for quick shifting of position stands out as a feature nowadays in that particular line of contractor's plant. The accompanying illustration shows the Archer Ford paving and building mixer, with a capacity of 7 cu. ft. of mixed concrete, the mixing equipment being mounted upon a Ford chassis and yet at a price, the producers point out—Ford truck and mixing equipment complete—only a little more than half what most paving equipment with equal capacity sells for. The machine is equipped with side loader, automatic water tank and 9 ft. paving chute with gate openings. The average capacity is from 100 to 150 yds. a day, say the manufacturers.

A similar outfit is also offered as low charging equipment, with the drum set directly on the truck chassis, equipped with loading platform for charging the materials into the drum direct with wheelbarrows. The side loader, water tan and paving chute is not provided with this equipment.

The thought of the manufacturers was to provide equipment not only for paving jobs, and especially for alley work, but to put equipment in the hands of the small contractor who has widely scattered small jobs and who can make money by saving time on moving his equipment.



Motor Truck Mounting for Crane

To take the crane to the job, the Byers Machine Co., Ravenna, Ohio, has brought out a crane that can be mounted permanently on a motor truck—the "Byers Truckrane," shown in the illustration. Increased mobility, together with the strength and comparative lightness of the unit, open a new field of crane service. Owners whose work has hitherto been too limited to operate a large crane, can, it is believed, use a machine of the "truckrane" type at a profit. Unmounted, the crane weighs 6 tons, and is similar to the Byers autocrane model 1 in every respect, except that it has no wheels, jack shaft, nor differential and drive chains. It has a power drum for raising and lowering the boom, which is of steel. It is furnished with a Hercules 4-cylinder 4 in. by 5 in. engine, developing over 30 h. p., to be operated with gasoline power. Any half cubic yard bucket weighing not over 2,000 lbs. can be used with it. It is pointed out as unnecessary to use a new truck, one that has seen 90% of its usefulness being suitable. The truckrane illustrated is owned and operated by the Worth Motor Service Co., of Chicago.

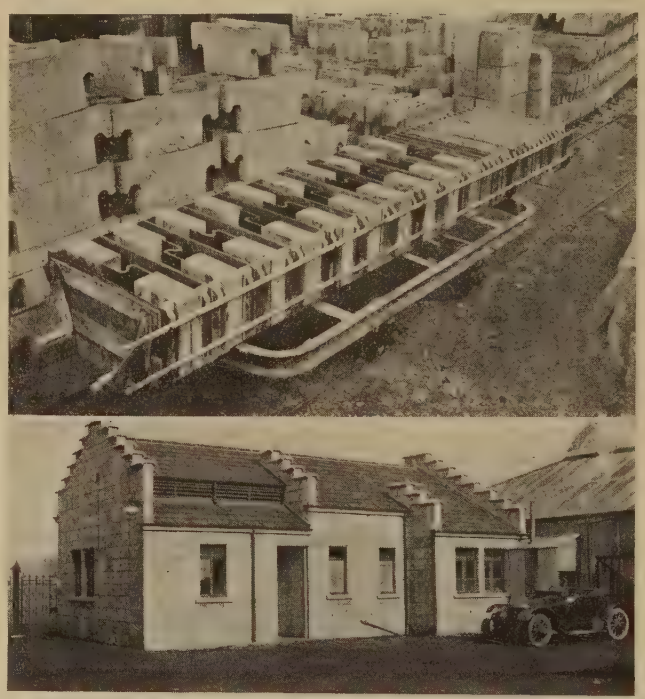
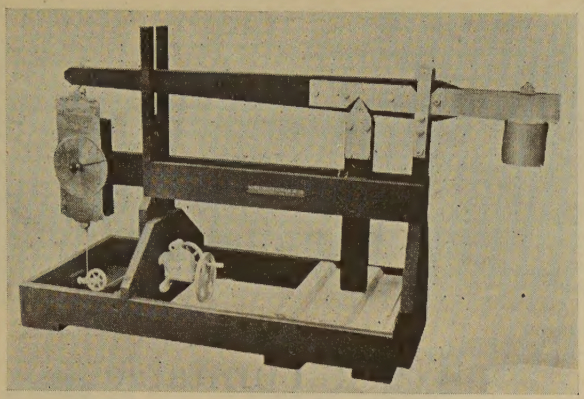


Fig. 1—Gang Mold for Making Ferguson Interlocking Block

Fig. 2—Building Erected with Ferguson Block

Ferguson Building Block

A new building block with recesses so arranged as to make it interchangeable and reversible, has been invented by Acheson Ferguson, of Belfast, Ireland. It has double hooked interlocking projections at two opposite sides, that is, there is a curved projection and an adjacent recess at each end of the block. It is made level at the other side so as to give a horizontal joint when built into a wall. Transverse bonding members are formed integral with the block and serve to bond together the outer and inner portions of a hollow wall built with this block. The transverse bonding members form a vertical hooked joint intended to prevent the passage of dampness from the outer blocks to the inner wall blocks. Outer and inner shells are in contact only at the bonded portions, which may be coated with damp-proof felt, waterproof cement, or other damp-proof material.



Roof Tile Testing Apparatus

Testing Roof Tile for Higher Quality

The quality of concrete roof tile made in various plants in different parts of the country is being investigated very carefully by the Walter Concretile Co., Indianapolis, which has devised a testing machine, as shown in the accompanying illustration, as a means of cooperating with Walter plants in an effort to bring Walter tile up to a definite standard of strength. Tests made thus far are preliminary and lack sufficient detailed data to make comprehensive analysis possible, yet the tests are nevertheless interesting.

In testing, the tile are placed beneath the breaking beam with the lugs resting on leather belting, so that the unit rests flat. The load is applied in the center of a 13½-in. span, between the lugs. A summary of the results of the tests made is as follows:

Plant No.	Weight Lbs.	Weight Oz.	Age	Mix	Breaking Load—Lbs.	General Remarks
1	5	9	3 mos.	1—2½	140	Sand sharp and clean
1	5	11	2 mos.	1—2½	182	Sand sharp and clean
2	5	13	28 mos.	1—3	209	Never exposed to weather
3	5	3	6 wks.	1—3	162	Dirt odor
3	5	3	6 wks.	1—3	95	Very porous; dirt odor
3	5	3	6 wks.	1—3	102	Very porous; dirt odor
3	5	1	6 wks.	1—3	140	Dirt odor
4	5	7	6 mos.		147	
5	5	3	3 mos.	1—2	179	
5	5	3	3 mos.	1—2	152	
6	6	1	12 mos.		152	
7	5	9½	4 mos.	1—3	117	Coarse sand, with little fine sand
7	5	5	14 mos.	1—3	177	All fine sand
8	5	9½	50 days		172	Excellent sand
8	5	7	2 mos.		112	Warped tile; excellent sand
8	5	9	3 mos.		187	Excellent sand
8	5	12	3 mos.		162	Excellent sand

Some of the things learned by these tests are these: Uniformity of pallets is important; a good tile cannot be made on a pallet of uneven thickness, or with warps or with edges and sides which are not ground parallel.

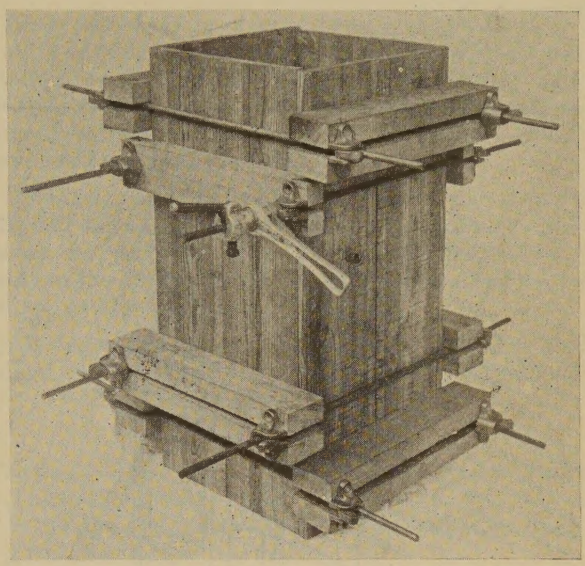
Too much oil on pallets for lubrication makes a weak tile. It is pointed out that pallets should be oiled and then set up and drained, so that all surplus oil is removed.

Too much water cannot be given the tile in the first two weeks after they are made.

Tile that are too much handled or vibrated while they are still green develop fine checks and frequently break at a low load.

With the average run of sand a 1 to 2½ mix is recommended. It is hoped to standardize the Walter tile at a weight of 5 lbs. 4 oz., and at a breaking load of over 155 lbs.

Comparative results of tests of this kind shown to individual plants is bound to be a spur to better work and to higher grade product.



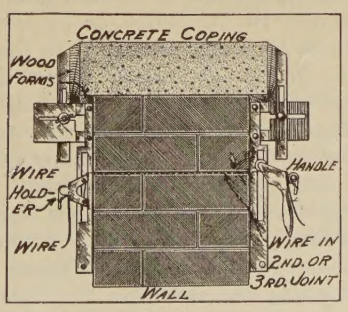
Phillips Form Clamp

Phillips Form Clamp

A new form clamp, which requires the use of only a ratchet tightener and a hammer in applying it to the forms, has been announced by the Victor L. Phillips Co., Seventh and Delaware streets, Kansas City, Mo. The type of clamp as shown in the accompanying illustration can be used to draw the form together so tight as to give it the appearance of one piece of wood, instead of several. There are no holes to bore, no wires to twist, and the rods used are plain round iron rods, which do not bend where the clamp fastens.

Combinations of these forms can be used on columns, pilasters, or walls of buildings, and can be used in the smallest working space. It is further claimed that a great saving results in the use of 2 in. x 4 in. instead of 4 in. x 4 in. lumber on wall constructions.

Milnes Adjustable Clamp

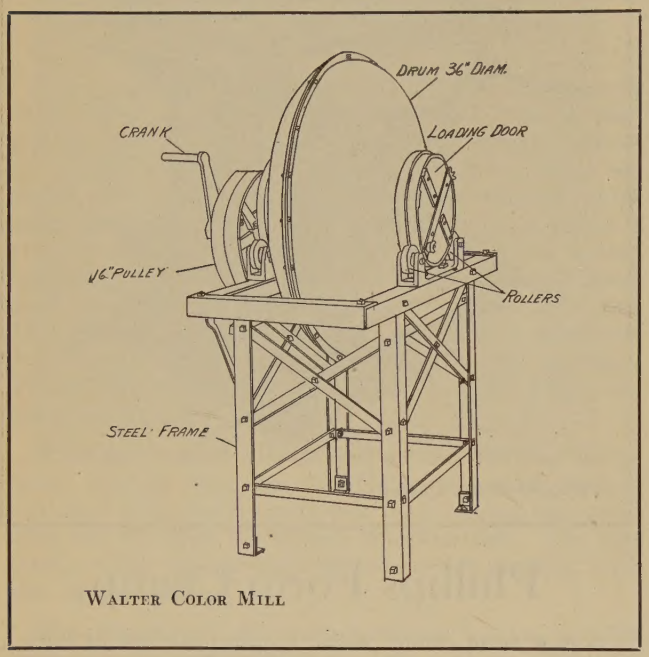


Milnes Form Clamp for Sills and Copings

The Milnes adjustable clamp is intended especially for handling sills and copings of concrete. It obviates the necessity for twisting wires between forms, elimi-

nates the usual spreaders, which frequently give trouble and provides a means of holding wires and getting all the tension of a wire extending through the lower part of the wall. It entirely eliminates anything in the way of overhead clamps or spreaders which would be in the way of finishing the top surface.

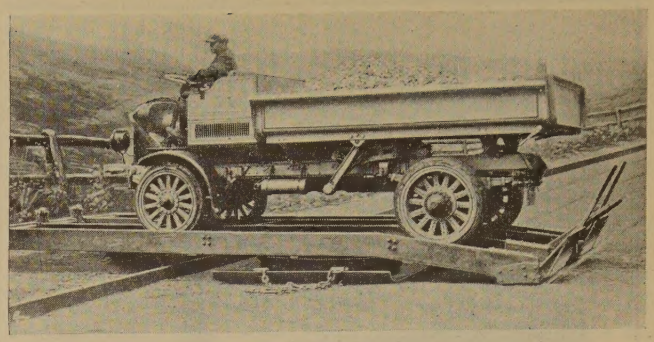
The illustration shows how it works. One clamp for any size wall. It is adjustable from flush to 3-in. projections, and heights of 3 in. to 10 in. The clamp is offered by John Milnes, Jr., 55 Clinton avenue, Port Richmond, N. Y.



WALTER COLOR MILL

Mill for Mixing Cement With Color

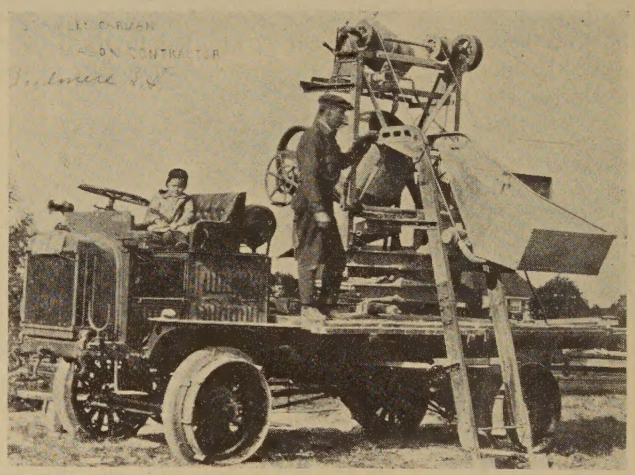
The permanence and durability of color in concrete is largely dependent upon the thoroughness of the mixing and grinding of the oxide color with the cement. To obtain a thoroughly ground and mixed material for use on the topcoat of a roof tile, the Walter Concrete Machinery Co. has developed a cast-iron ball mill with steep sides. It can be operated either by hand or power, and it is of a convenient size to take care of the requirements of the average roof tile plant. Most color mills have not been suited to the needs of products manufacturers. The mill has a 36-in. diameter cast-iron mixing drum, which is ⅜ in. thick. The speed is 70 r. p. m. The power is applied through a system of internal gearing, which is operated by the 16 in. pulley or by the hand crank. The material to be mixed is placed in the drum through a 14-in. hole in the side, which is closed up by a cover plate. There are ten 6-lb. cast-iron balls on the bottom, which grind and mix the material as the drum rotates. Because of the speed and shape of the drum and the rolling action of the balls, the material is carried part way up the sides of the drum and tumbles down and is constantly reground. The drum and gearing is supported on a well braced steel frame. Provision is made for fastening the frame to the floor when the drum is being operated by power. The mill was made primarily for the use of roof tile plants, although it is practical for the use of any kind of concrete product plant using color.



Truck Turntable

Announcement has previously been made of the Blaw-Knox truck turntable for the road contractor. The accompanying illustration shows it in use. In designing this equipment there were several essentials clearly in mind; it must handle trucks up to 5 tons, have a wheel-base measuring up to and including 168 in., and have an over-all width such that it would not take up more than 8 ft. of roadway when truck is mounting or backing off. It must be capable of turning over the road road forms to secure maximum efficiency.

It is reported that the number of Blaw-Knox turntables which are in use justify their expectations along these lines. They are produced in 2½, 3 and 5-ton sizes, all of which are easily operated by one man. It moves on a skid, which is said not to damage the road grade.



Mixer Mounted on Truck

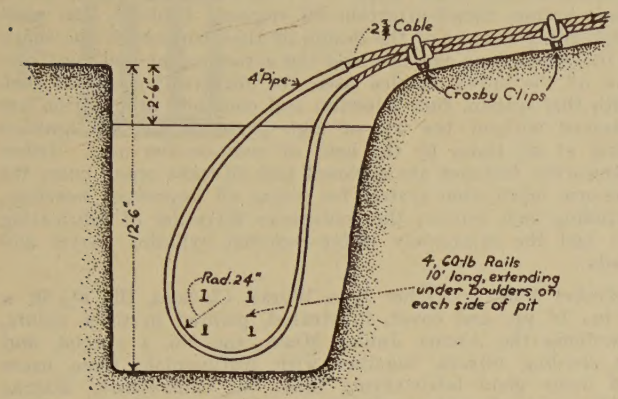
The accompanying illustration shows a concrete mixer mounted on a four-wheel drive truck, on the two front wheels of which 10-in. steel flanges are mounted, rear wheels having 12-in. flanges. This rig was developed by Stanley Carman, mason contractor, Woodmere, Long Island, in order to get his mixer on the ground quickly, move it around easily, and handle it on soft ground.

Saw Rig

A home builders' saw-rig, size 70 x 30 in., and weighing 700 lbs., and with a 3 h. p. gasoline engine—an outfit intended for all-around use on the house job, up and down stairs, indoors and out—is offered by the C. H. & E. Manufacturing Co., Inc., Milwaukee, Wis.

An Unusual Type of Guy Anchor

A method of fastening 2¾-in. cable to an anchorage without sacrificing any of its strength, was employed on cableways used recently in the construction of the Kern Canyon plant of the San Joaquin Light & Power Corporation, near Bakersfield, Cal. When the concrete anchorage was being cast, there was embedded in it a 4-in. pipe bent in the form of a loop with both ends projecting on top of the anchorage, the minimum radius being about 2 ft., as shown in the accompanying drawing. When the concrete had hardened, the end of the cable to



be anchored was welded to the end of a ½-in. cable, which was passed through the pipe and used to pull the main cable through. The end of the cable was then made fast with five Crosby clips 30 in. apart. The pipe was filled with grease before the main cable was pulled through. This made it easy to get the cable in and out, and, when waste was stuffed in the ends of the pipe, also prevented rusting. After the completion of the work the cable was easily removed and its entire length salvaged.—*Engineering News-Record.*

Books

Concrete Work—William K. Hatt and Walter C. Voss. Two volumes, 5¼ in. by 7⅝ in.; cloth, illustrated; John Wiley and Sons; Vol. 1, 451 pp., $4.00; Vol. 2, 206 pp., $2.00.

In these days of an almost universal quest for knowledge concerning the "how" and "why" of things, on the part of those engaged in the practical side of construction work, this addition to the Wiley Technical Series should find many readers. Prepared for the instruction of army men during the war, it is written in a manner that is easily understandable. The book contains no involved mathematics, a knowledge of arithmetic being sufficient preparation to read it. It is written primarily for those concrete workers of unguided experience who wish to attain positions of foremen or contractors on concrete construction.

The subject is presented in two volumes. Volume 1 contains the development of principles and information of methods of construction and standards, necessary for actual building construction. The chapter headings are: Opportunities in the Concrete Industry; Plans; Details and Specifications; Simple Footings; Column Footings; Concrete Walls; Reinforced Concrete Frames; Erection; Pre-Cast Stone; Walls and Partitions; Walks and Pavements; Building Finish; Special Construction and Estimating. The appendices contain information on Aggregates; Manufacture of Cement; Standard Specifications and Tests; Specifications for Concrete Storage Tanks and Reservoirs; Waterproof Construction and Data for Estimating.

Volume 2 contains 206 pages, 37 figures and 97 job sheets, that uncover to the worker the fundamental principles and operations of computing, selection of materials, mixing and placing of concrete. They may be classified into elementary operations; tests of materials; inspection of construction; construction methods; study of materials and methods; experiments and information.

Each job sheet involves a title, a direction or order to do a certain thing; a series of development questions, intended to develop the thought of the worker and to bring him to the point where he can make his own decisions from time to time upon the various situations that may confront him.

Foremen, local concrete contractors, and inspectors will find these volumes invaluable practical books of reference for everyday use. They fill the important gap between the theory of the engineer and the special technology of the contractor.

An "answer book" to the problems contained in this volume can be obtained from the publishers for 25 cents.

Hendricks Commercial Register of the United States—Thirtieth edition, 1922; size, 8½ in. by 11½ in.; 2,164 pp., cloth, $12.50; S. E. Hendricks Co., Inc., 70 Fifth Ave., New York.

One of the striking features of the book is its simple method of arrangement and complete index, making it easy to use. This ease of use is increased by the exterior index, a feature which has been continued this year.

It contains many advertisements which in no way obscure the lists, but in fact give the user much valuable additional information.

The scope of the work is increased by the incorporation of "The Assistant Buyer," which makes it a complete register of producers, manufacturers, dealers, and consumers connected with the electrical, engineering, hardware, iron, mechanical, mill, railroad, steel, and many other allied industries, as well as many others of interest to buyers and sellers. Products are listed from the raw material to the finished article, with the concerns handling them in this process. It is indispensable as a buyers' reference as well as valuable for preparing mailing lists.

Proportioning Sand With Varying Moisture Content

By Irvin D. Foos

Preliminary investigations have indicated that if the vessel in which the sand is measured contains sufficient water to submerge the sand, the same quantity of sand can be placed in the vessel regardless of the quantity of moisture originally obtained. The Bureau's investigation is to determine whether the measurement of sand inundatd will affect uniformity in the proportioning of sand to cement, and consequently uniformity in the strength of the concrete. An affirmative answer to this question would mean the solution of one of the most troublesome problems in the concrete industry.

Organizations

American Concrete Institute; Secretary, Harvey Whipple, 1807 East Grand Boulevard, Detroit. Convention, Cincinnati, Ohio, January 22-25, 1923.

American Concrete Pipe Association, M. W. Loving, Secretary, 111 West Washington St., Chicago.

American Engineering Standards Comm., Dr. P. G. Agnew, Secretary, 29 W. Thirty-ninth Street, New York City, December 14, 1922, 29 W. Thirty-ninth Street, New York City.

Asso. General Contractors of America, G. W. Buchholz, Secretary, 1038 Munsey Bldg., Washington, D. C. Convention probably January 30 to February 2, 1923. Los Angeles, Cal.

Associated Metal Lath Manufacturers, Edison Bldg., Chicago; Wharton Clay, Commissioner.

Portland Cement Association; William M. Kinney, General Manager, 111 West Washington Street, Chicago.

Iowa Cement Stave Silo Association; H. E. Kilmer, Secretary, Oskaloosa, Ia.

Mid-West Concrete Products Assn., Frank Whipperman, Secretary-Treasurer, 3045 Fowler Bldg., Omaha, Neb.

National Crushed Stone Assn.; A. P. Sandles, Secretary, 405 Hartman Bldg., Columbus, Ohio.

National Housing Assn.; Lawrence Veiller, Secretary and Director, 105 East 22nd St., N. Y. C.

The National Lime Association; Mather Bldg., Washington, D. C.

National Sand and Gravel Producers' Association; T. R. Borrows, Acting Secretary, 903 Munsey Bldg., Washington, D. C.

The National Concrete Stave Silo Association; W. G. Kaiser, Secretary, 111 West Washington St., Chicago.

Trade Publications

Hug Equipment—The Hug Co., Highland, Ill., 8½ x 11, 4 pp., illustrated; describing and illustrating the road building equipment manufactured by this company, featuring a truck turntable, especially for the road builder, occupying only 7½ ft. width on road.

Mack Year Round Steel Cabs—International Motor Co., New York City, 8 in. x 10½ in., 8 pp., illustrated; describing the Mack year round cabs that protect the truck driver from the wind and rain.

Profits Are Regulated by Time Saved—Blaw-Knox Co., Pittsbugh, Pa., 8 in. by 11½ in., illustrated, printed in two colors, 8 pp.; showing how Blaw-Knox road building equipment cuts down the time required for various operations in road building.

Kwik-Mix Concrete Mixer—Badger Wire & Iron Works, Milwaukee, Wis., 4 in. by 9 in., 16 pp. and cover. Illustrates and describes a small light mixer for farm use and light contract work. A dozen or more uses for concrete on the farm are described and illustrated, besides full description of the different parts of the machine being given.

Builders' Mixers—Thousands in Daily Use—The American Cement Machine Co., Inc., Keokuk, Iowa, 8¾ in. by 11½ in., 8 pp. This catalog describes and illustrates No. B7S with such equipment as extra batch hopper, with power; barrow hopper; loading platform and tank; with power loader and pressure tank; and with the batch hopper and extra hoist attachment. Dimensions, specifications and shipping information as well as full description are also given for the big reliable Stover engine. No. B4S mixer is also described and the back cover is devoted to illustrations of different types of labor saving devices for contractors.

Monarch Casement Hardware—Monarch Metal Products Co., 5020 Penrose St., St. Louis, Mo., 7½ in. by 10½ in., 18 pp. and cover, describing and illustrating Monarch control locks, automatic stays and checks, for casement windows. Different types, such as for casement windows, for pivoted windows and for pivoted sashes are also shown, together with various finishes.

Mandt Automatic Dump Body—Mandt Co., Keokuk, Iowa, a 4-page folder, 8½ in. by 11½ in., in two colors. This 4-page folder describes and illustrates the following types of Mandt dump bodies: heavy duty 1½-yd. body, heavy duty 2-yd. body, 1-yd. body for Ford trucks, or other light trucks, gravel or stone spreading body, garbage or grain body, and the hopper type body. Dimensions of and attachments for these different types are all given.

"Bulletin 10,004—Ingersoll-Rand Co., 11 Broadway, New York, describes Price Type "PO" horizontal, single cylinder, single acting, direct-injection oil engine. Probably the most outstanding feature of the design of these engines is the shape of the combustion chamber and the arrangement and construction of the spray nozzles used for direct-injection of fuel. With this system, fuel injection and complete atomization are obtained without the use of high pressure air, the ignition being at all times by the heat of compression only. Other noteworthy features are enclosed and oil-tight crank case; the pressure lubrication system for oiling all important bearings, including cam rollers; the continuous filtration of lubricating oil; and the completely water-jacketed cylinder barrel and heads.

Archer Mixers—Archer Iron Works, Chicago, Ill., 8½ in. x 11 in., 16 pp. and cover, illustrated, printed in three colors, describing the Archer Junior Mixer, the No. 1 special, and the one-bag mixers, together with testimonials from users and many good labor-saving ideas for contractors. Extras which can be furnished with the mixer are also mentioned.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912.

Of CONCRETE, published monthly at Detroit, Michigan, for October 1, 1922.

State of Michigan, } ss.
County of Wayne, }

Before me, a Notary Public, in and for the State and County aforesaid, personally appeared R. Marshall, who, having been duly sworn according to law, deposes and says that he is the General Manager of CONCRETE, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and, if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in Section 443, Postal Laws and Regulations, printed on the reverse side of this form, to-wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher—Concrete-Cement Age Pub. Co., Detroit, Mich.
President—R. Marshall, Detroit, Mich.
Managing Editor—Harvey Whipple, Detroit, Mich.
General Manager—R. Marshall, Detroit, Mich.

2. That the owners are (Give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders owning or holding 1 per cent. or more of the total amount of stock).

Concrete-Cement Age Pub. Co., 1807 E. Grand Blvd., Detroit, Mich.
R. Marshall, 1807 E. Grand Blvd., Detroit, Mich.
Harvey Whipple, 1807 E. Grand Blvd., Detroit, Mich.
F. F. Lincoln, Room 1205, 115 Broadway, New York City.
R. N. Jackson, 1807 E. Grand Blvd., Detroit, Mich.
R. W. Lesley, Penn Bldg., Philadelphia, Pa.
Edward B. Bruce, Manila, P. I.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities, are: (If there are none, so state.) None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest, direct or indirect, in the said stock, bonds, or other securities than as so stated by him.

5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers, during the six months preceding the date shown above is ——— This information is required from daily publications only.)

R. MARSHALL,
Manager.

Sworn to and subscribed to before me this 28th day of September, 1922.

(Seal.) IONE MICHAEL.
(My commission expires April 9, 1923.)